BOARD OF AGRICULTURE AND FISHERIES.

LEAFLETS

(Nos. 1 to 100).

TENTH EDITION.
WITH INDEX.

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The Board of Agriculture and Fisheries first issued their leaflets (Nos. 1–100) in book form in 1904, and since then some 43,500 copies of the volume have been sold or otherwise disposed of. Several of the leaflets in the present edition have been revised. The General Index and the Special Index will be found useful.

The Board hope that those who possess a copy of this volume will make its existence known to all to whom it is likely to be of practical interest.

The second hundred leaflets (Nos. 101–200) are issued in a companion volume to the present one, price 6*d.* nett, post free.

Many of the leaflets 1–200 are also published in pamphlets containing leaflets on closely related subjects, and these pamphlets may be obtained on application, price 1*d.* each, or 9*d.* per dozen copies, post free. The pamphlets at present available are described on pp. 4–5.

The leaflets will continue to be issued singly, and copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

4, Whitehall Place, London, S.W.,
August, 1912.

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(1.) List of Leaflets 1-100 as arranged in the Pamphlets referred to on p. 3, with titles of the Pamphlets available.

No.	Title.	No.	Title.
	(1.) Acts of Parliament and Miscellaneous Subjects.		
8	Assessments to Local Rates.	39	Assessments to Land Tax.
17	Preservation of Commons.	59	Improvement of Land Act.
26	Farmers and the Income Tax.		
27	Remission of Tithe Rent-charge.	97	Farmers' Co-operative Societies.
	(2.) Farm Animals and Dairying.		
81	A Substitute for Dishorning.	100	Pig Breeding and Feeding.
82	Preparation of Wool for Market.		
	(3.) Diseases and Insect Pests of Farm Animals.		
13	Acorn Poisoning.	61	Sheep-Scab.
21	Warble Flies.	89	Fluke, or Liver Rot in Sheep.
28	Anthrax.	95	Ringworm in Cattle.
29	Swine-Fever.	96	Milk Fever or Parturient Apoplexy.
37	Rabies.		
	(4.) Poultry and Bees, their Breeding and Management.		
32	Foul Brood or Bee Pest.	67	Favus or White Comb in Poultry.
57	External Parasites of Poultry.		
58	Nematode or Round Worm Diseases of Poultry.	78	Tuberculosis of Poultry.
		83	Preservation of Eggs.
66	Fowl Cholera.		
	(5.) Cultivation of Fruit Trees and Farm and Garden Crops.		
7	Autumn Catch Crops and Fodder Supply.	73	Cultivation of Maize for Fodder.
9	Ensilage.	85	Haymaking.
		98	Grading and Packing Fruit and Vegetables.
63	Destruction of Charlock.		
	(6.) Manures and Feeding Stuffs.		
18	Fertilisers and Feeding Stuffs Regulations, 1906.	79	Rations for Farm Stock.
		80	Use of Artificial Manures.
72	Purchase of Artificial Manures.	93	Farmyard Manure.
74	The Composition and Properties of Concentrated Feeding Stuffs.		
	(7.) Forest Trees and their Diseases.		
25	Chafer-beetles or White-grubs.	64	White Root Rot.
36	Cultivation of Osiers.	91	Pine Beetle.
60	Goat Moth and Wood Leopard Moth.	99	Relationship of Woods to Domestic Water Supplies.

(8.) *Wild Animals and Birds.*

No.	Title.	No.	Title.
6	Voles and their Enemies.	50	Water Wagtails or "Dish-washers."
40	Kestrel or Wind-hover.	51	White or Barn Owl.
42	Short-Eared Owl.	54	Spotted Flycatcher.
43	Titmice.	55	Swallow.
44	Lapwing, Green Plover, or Peewit.	84	House-Sparrow.
45	Starling.		

(10.) *Insect and other Pests injurious to Fruit Trees and Bushes.*

No.	Title.	No.	Title.
1	Black Currant Gall Mite.	49	Fruit Tree Beetle.
2	Vine, Plum, Hop, and Raspberry Weevils.	53	Pear Midge.
4	Winter Moths.	62	Pear and Cherry Sawfly.
12	Gooseberry Saw-fly.	65	Small Ermine Moths.
14	Raspberry Moth.	68	Currant Aphides.
15	Apple Blossom Weevil.	69	Tent Caterpillars.
16	Apple Sucker.	70	Winter Washing of Fruit Trees and the Treatment of Neglected Orchards.
20	Magpie Moth.	90	Pith Moth.
30	Codling Moth.		
34	Woolly Aphis, or Apple Root Louse.		

(11.) *Fungi injurious to Farm and Garden Crops.*

No.	Title.	No.	Title.
23	Potato Disease.	77	Finger-and-Toe in Turnips.
76	Cucumber and Melon Leaf Blotch.	92	Bunt and Smut.

(12.) *Fungi injurious to Fruit and Fruit Trees.*

No.	Title.	No.	Title.
52	European Gooseberry Mildew.	86	Brown Rot of Fruit.
56	"Canker" Fungus.	87	Fungus Disease of Young Fruit Trees.
64	White Root Rot.		

(2.) List of Leaflets in alphabetical order.

(2.) List of Leaflets in alphabetical order—*cont.*

BOARD OF AGRICULTURE AND FISHERIES.

The Black Currant Gall Mite (*Eriophyes* (*Phytoptus*) *ribis*).

FIG. 1.

FIG. 2.

Fig. 1. Black currant mite (much magnified) erecting itself upon its terminal suckers (after E. J. Lewis). Fig. 2. Twig of black currant in which an uninjured bud has opened. Two lower buds are hindered by presence of mites, while the lowest buds are swollen by them.

The so-called Big-Bud disease of the Black Currant due to this mite has been known in this country for at least 60 years, but latterly the disease has spread all over the country, and the damage done has been so great that in some districts black currant growing has ceased, the black currant being replaced by some other crop. All cultivated varieties of the black currant fall victims to the disease, which is caused by the presence in the buds of mites of the species *Eriophyes ribis*. As a result of the irritation caused by the presence of the mites and the pricking of the delicate young leaves by the mandibles of the mites in their feeding, the buds swell greatly and become somewhat rounded in shape. If the buds are badly infested then neither leaves nor flowers develop, the buds remain unopened, and

after retaining their green colour for a time they ultimately dry up and become brown. Buds containing a smaller number of mites may burst at the proper season, but the shoots and leaves are dwarfed.

The Mite belongs to the Class *Arachnida* (spiders, mites and scorpions), the Order *Acarina* (an Order numbering in it the red spiders, the mange mites and the ticks) and the Family *Eriophyidæ*. These Eriophyidæ are feeders on plants, and are distinguished from all other mites by their having a somewhat worm-like elongated body with only 4 legs, each leg having 5 joints.

Description.

The Mite.—The Mite is practically invisible to the naked eye, measuring in length scarcely 1–100th part of an inch. The body may be divided into two regions, a broad anterior cephalo-thorax, protected above by a furrowed shield and running out into a snout-like head bearing the piercing and sucking mouth-parts; and an elongated abdomen with a series of transverse rings with rows of projections on them. At the end of the abdomen are two rounded flaps which can be brought together to act as a muscular sucker by which the mite can erect and support itself. At the front end of the mite are 4 short legs; these legs are 5-jointed and bear bristles, the end joint being furnished with a claw. The body carries five pairs of bristles: a pair behind the legs; a longer pair about the middle of the body; a third pair, the shortest, on the under surface; a fourth pair, slightly longer, also on the underside of the body posteriorly; and a fifth pair, the longest of all, springing dorsally from the tail end and capable of service to the mite in locomotion.

The Mite is whitish or pale green in colour and has a glassy semi-transparent appearance.

The eggs are large for the size of the mite; they are greenish in colour and have a horny covering.

Life History.

Details of the life history have been worked out by Lewis, Warburton, Embleton, and Collinge.

The mites feed and shelter in the buds over winter. Buds that have been only partially infested may open out in March, and the mites thus exposed and deprived of shelter may leave their hiding place. It is believed that most of the mites from this chance migration perish. The real migration of the year takes place from badly infested and destroyed buds, which do not expand, and from partially infested buds that have opened late. This migration takes place from about the middle of April onward—there are variations according to the season—increasing in intensity during May and spending itself

somewhat by the middle of June. It should be noted that this migratory period is the vulnerable period in the life of the mite—the time when treatment, to be successful, should be applied. During this time mites may be found in numbers on the shoots, at the base of the leafstalks, on the flower-stalks, on the flowers, and in collections round the young buds which are to provide the new homes for the migrants.

Migration may take place by crawling or by the mites attaching themselves to passing insects and other animals. In waiting for such attachment, the mites are found occasionally to assume an upright position fastened by the sucker at their tail end. Where lodgment is not obtained on a passing animal the mite seems to launch itself into space, with the possibility of landing on or near a bud; most that fall to the ground in this way probably fail to get back to the bushes.

These migratory mites are adults, and, having entered the new buds and made their way inwards, the females—many of them already full of eggs—proceed to lay. The eggs hatch in due course, and buds crowded with the new generation show at the end of August and in September the characteristic swollen appearance.

Eggs have been found in the buds in all the months of the year, but in the winter months the number is comparatively small.

Preventive and Remedial Measures.

(1) The grower should cultivate from clean stock only, rejecting bushes that show swollen buds.

(2) Cuttings from infested plants should not be used. To disinfect cuttings Pickering recommends immersing them in water at 115° F. for ten minutes before planting.

(3) Where the disease is limited to a few bushes these should be uprooted and burned.

(4) Handpicking the swollen buds may, in an isolated area, keep the pest in check.

(5) Hard pruning followed by the removal by hand of suspiciously large buds has often been tried, sometimes with fair results, sometimes without manifest improvement.

(6) Fumigation with hydrocyanic acid gas has been experimented with, but the results are not such as to justify a recommendation of this treatment, especially in view of the difficulties attending fumigation over a wide area in the open.

(7) Dusting or spraying with a mixture of lime and sulphur. Collinge recommends one part of unslaked lime and 2 parts of flowers of sulphur, mixed together and dusted three times on the bushes when they are wet, at the end of

March or the beginning of April, again in the middle of April, and again in the first week of May. Encouraging results have attended this treatment, though in some cases no benefit can be said to have resulted.

(8) A soft soap and water spray has been recommended against the mite. A suitable mixture might be made up by using 15 lb. soft soap and 24 lb. quassia per 100 gallons of water. Affected bushes should be sprayed at frequent intervals from the middle of March until the middle of June.

To some extent the Black Currant Mite is kept down by natural enemies, such as the common ladybird (*Coccinella septempunctata*), the lacewing fly (*Chrysopa*, sp.), and a species of hover fly (*Syrphus*, sp.). The larva of a *Cecidomyid* and that of a *Muscid* have been found feeding in infested buds. A. M. Taylor has described (*Jour. Econ. Entom.*, 1909) the larva of a chalcid (*Tetrastichus eriophyes*) as preying on the mites, and also a parasitic fungus (*Botrytis eriophyes*) as very deadly to the mites.

During the year 1907 Theobald recorded (through a correspondent) the fact that white currants and also red currants had been attacked by *Eriophyes ribis*. This attack should be noted, and bushes showing it should at once be burned.

4, Whitehall Place, London, S.W.,
April, 1894.

Revised, April, 1910.

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BOARD OF AGRICULTURE AND FISHERIES.

Vine, Plum, Hop, and Raspberry Weevils.

The weevils included under the above heading comprise (1) the Black, or Vine Weevil (*Otiorhynchus sulcatus*, Fab.), (2) the Clay-coloured, or Raspberry Weevil (*Otiorhynchus picipes*, Fab.), (3), the Red-legged, or Plum Weevil (*Otiorhynchus tenebricosus*, Herbst.), and (4) the Ivy and Hop Weevil (*Liophlœus nubilus*, Fab.). Other species do damage, but the four named are the most abundant.

These weevils frequently do much harm to many plants and trees, among which may be noted vines, mangolds, peas, beans, young turnips, strawberries, raspberries, plums, cherries, peach and nectarine trees, and ferns and flowers of various kinds in pots and borders, in greenhouses or in the open air. In 1894 the first two of these weevils were unusually troublesome; the hot dry summer of 1893 appeared to be very favourable for their increase. Every year, however, there is more or less complaint. Hop plants are sometimes seriously injured by them, mainly, however, by the clay-coloured species (*O. picipes*), and the ivy and hop weevil (*L. nubilus*), though occasionally the dark-coloured species (*O. sulcatus*) is found on these plants. The hop bines flag, their heads droop just after they are tied to the poles, and they have deep punctures here and there. In some cases these punctures are so deep that the bines are nearly cut in two. In the same way the tender shoots of vines are punctured by the vine weevil, and the juicy sprouts of raspberry canes by the first three species mentioned above.

Besides the damage done to hop plants through the leading shoots of the bines being cut off or so weakened as to be practically useless, the "hills," or plant centres, are much injured by the grubs, or larvæ, which feed upon them during the late autumn and winter. This injury has in many cases been attributed to wireworms. The roots are especially damaged by the grubs of *O. picipes*, which burrow into them and soon cause decay.

Strawberry growers often experience much loss from these beetles in the adult stage, but more particularly from the grubs or larvæ. The grubs burrow into, and feed on, the roots and crowns of the plants from September until March, and after April the weevils pierce the shoots and runners.

Gardeners who find such plants as dracænas, cinerarias, cyclamens, primulas, spiræas, sedums, and others, withering or dying in greenhouses and borders, should search among the roots for the white grubs of the weevils. If the young succulent shoots of vines are found to be pierced and nearly severed, it is certain that there are weevils in the soil near the vine stems, and action should be taken against them.

Peach, nectarine, apple and pear trees are frequently injured by weevils, which bite the shoots and cause the sap to escape just when it is required for the development of the fruit.

The Black, or Vine Weevil.

(*Otiorhynchus sulcatus*, Fab.)

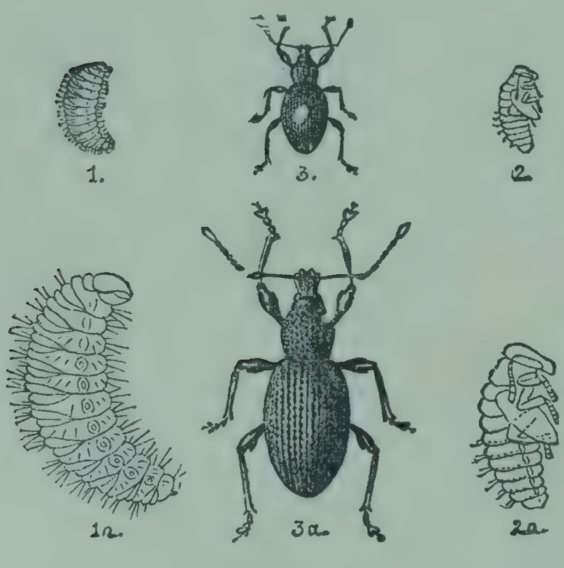


Fig. 1.

Larva 1, 1*a* ; pupa 2, 2*a* ; weevil, 3, 3*a* ; natural size and magnified.

Description.—This weevil is termed *sulcatus* because of the broad, deep furrow on its short rostrum. It is about two-fifths of an inch long, black, with greyish hairs upon the head and thorax, has reddish antennæ with clubbed apices, and dark coloured legs. The elytra have somewhat deep furrows with a few yellow hairs. No wings are present.

The legless larva is creamy white, and bears many brownish hairs; the jaws are yellow-brown; it lies curved in the manner shown in the figure. The pupa is yellowish-white in colour, and is covered with reddish hairs; it is not enclosed in a cocoon.

Life History.—Eggs are laid in the summer, and the grubs, or larvæ, are found, from the early autumn until March, in the earth near to, and among, the roots of plants. The pupal stage is assumed in the early spring, and according to Taschenberg lasts 14 days. The pupa is found at a depth of from $2\frac{1}{2}$ to 4 inches in the earth. When the weevil emerges, it at once attacks the plants near it, feeding only at night. When disturbed, it feigns death, and remains immovable for a long time. It is tenacious of life in an extraordinary degree, and in its weevil state disregards heat, cold, and the most pungent odours. Curtis says that nothing but boiling water and turpentine seems to annoy this insect.

The Clay-coloured, or Raspberry Weevil.

(*Otiorhynchus picipes*, Fab.)

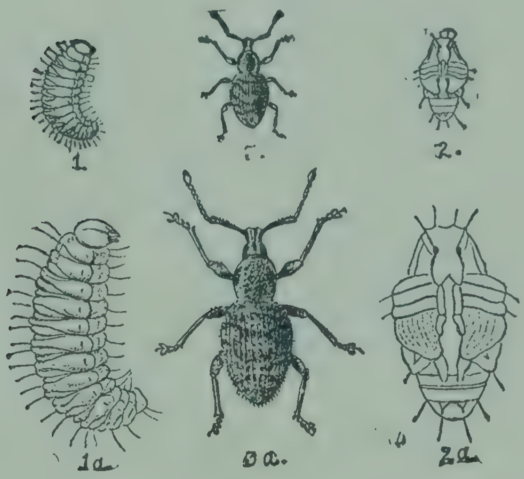


FIG. 2.

Larva, 1, 1*a* ; pupa, 2, 2*a* ; weevil 3, 3*a* ; natural size and magnified

Description.—The clay-coloured, or raspberry, weevil varies from one-fourth to a little under one-third of an inch in length. Its head and thorax are of a pitchy colour, and the elytra somewhat brown, but these are thickly covered with light-coloured scales, which make the weevil of the colour of clay, so that it is almost impossible to detect it in clayey soils. These scales, seen under the microscope, appear like beautiful mosaic or tessellated work. The weevil is rather ovate in form, and has dark-red or pitchy-red legs, as Schönherr describes them, with pitchy 12-jointed antennæ furnished with clubs. The femoral teeth, as Schönherr notes, are very indistinct, and in many cases imperceptible. There are long bristles upon the rostrum, and rows of short bristles down the furrowed elytra. This insect has no wings, and is a night feeder.

The legless larva is white or yellowish white in colour, is thickly covered with hair, and has a brown head.

Life History.—The life history resembles that of *O. sulcatus*. Eggs are laid in the ground and the larvæ feed on roots throughout the summer and autumn until the spring, when they change to whitish pupæ with black eyes.

The Plum, or Red Legged Weevil.

(*Otiorhynchus tenebricosus*, Herbst.)

Description —In length the plum weevil, so-called because of its apparent partiality for plum foliage, varies considerably; the usual size is about half-an-inch long, but small specimens may be found two-fifths of an inch long. It is black in colour and shiny in appearance; the wing-cases bear lines of punctures, and in quite fresh specimens some ashy-grey scales; and the legs are dull red.

The eggs are at first white, but in two days become jet black.

The larvæ are very similar to the two former species.

The pupa is pale and brownish-white.

Life History.—This weevil is one of the most destructive to the plum, raspberry, strawberry, cherry, apricot, nectarine and peach in the London district and the South and South-East of England, especially on chalk soils. The beetles strip the shoots of their leaves, destroy the buds, and even attack the bark, while their larvæ devour the rootlets and roots of the strawberry, &c. during the winter. Like the two species already mentioned, the plum weevil is mainly nocturnal in habits. The eggs are laid just under the ground; they hatch in August and September, and the larvæ remain feeding upon strawberry and other roots until the following March or April. The pupa is found in an earthen cell, and, as a rule, about 2½ inches beneath the surface of the ground, where it remains from fourteen to twenty-one days. This weevil is apparently double brooded.

A closely related species (*O. fuscipes*, Walton) also works in a very similar way.

The Ivy and Hop Weevil.

(*Liophlœus nubilus*, Fab.)

Description.—The weevil varies considerably in size; small males occur only one-third of an inch in length, while some females are as much as three-fifths of an inch long. In colour it is black, densely covered with ashy-brown scales; the wing-cases bear small tessellated spots and punctured lines; and the legs are dark, and rather hairy.

Life History.—Several reports of the damage caused to hops by this weevil have been received from growers in Kent. This weevil lives in hedges, on various young trees

and on ivy and other plants. It damages hops by biting the bine, especially attacking the tender shoots. Like the other *Otiorhynchi* it works at night, hiding between the bine and the pole or in the earth of the "hills" during the day. It frequently becomes covered with the earth, in which it hides. Nothing seems to be known of its life history.

Preventive and Remedial Measures.

As the weevils described above feed upon many trees and plants, it will be found that they often come from hedgerows round fields cropped with hops, peas, beans, mangolds, turnips, or fruit bushes, and gradually infest these crops. In some hop gardens in Kent they spread from rows of poplars planted as shelters, or "lews," for the hop plants. In others they came from raspberry and currant plantations near. As they cannot fly, their progress is slow, and they should be prevented by active measures from advancing in fields where they are discovered.

1.—They may be caught upon hop plants and raspberry plants by holding tarred boards near the ground at night, and tapping the poles or stakes so that the insects fall into the tar.

2.—Some hop planters send men with lanterns to pick them from the hop bines at night. In this way many weevils may be caught.

3.—They would be disturbed by prong-hoeing close round the plants, and hoeing in lime and soot mixed together. A constant moving of the soil with nidgetts, horse-hoes, and hand-hoes, would tend to check the progress of the weevils in the case of hops, mangolds, peas, beans, and turnips.

4.—In infested hop-land and fruit-land, where the plants are permanent, besides constant hoeings and the application of caustic materials in May and June, when the weevils are active, the soil immediately round the plant centres and bushes should be treated in the autumn with lime and soot, or earth, sand, sawdust, or ashes saturated with paraffin oil at the rate of from four to five pints to a bushel.

5.—In strawberry fields it is most difficult to cope with these insects, but when infested fields are grubbed up they should not be replanted with strawberries for two or three years.

6.—Strawberry plants in gardens that have become infested with weevils should be examined closely in late autumn, and the grubs picked out from the roots as far as possible.

7.—In regard to strawberries, one point of importance to notice is that the beetles seek shelter beneath which to deposit their eggs, and this is readily found under the straw or grass put between the rows to keep the fruit from the earth. In all cases the straw should therefore be put on as late as possible, and cleared away as soon as the fruit is gathered.

8.—With regard to vines in houses, the weevils may be shaken at night on to tarred boards, or cloths spread under the vines, or they may be picked off them. The treatment must be repeated.

9.—Where peach, nectarine, and other wall fruit trees are attacked, the walls should be kept free from holes, and often whitewashed; the base of the wall should be thickly tarred, and ash and tar spread along the foot of the wall. The tarred boards may also be used at night, or the weevils may be picked off by hand.

10.—The roots of plants in pots should be freed from the grubs, and if there is an attack on flowers in borders their roots and the soil near them should be examined and the grubs picked out.

11.—For the destruction of weevil and other grubs at the roots of plants Theobald recommends watering with the following mixture:—"One quart of soft soap dissolved in one gallon of boiling soft water, to which add one pint of crude carbolic acid. Mix the whole, by means of a force pump, into an emulsion. For use add 30 times the amount of water to each part of the emulsion. The earth should be removed from the roots before watering."

Natural Enemies.

These weevils, although not materially checked by them, have several natural enemies. Amongst the most important are the so-called sand wasps, or *Odyneri*. These wasp-like insects provision their nests with the adult weevils, which they kill or paralyse with their sting, and upon these the wasp larvæ feed when hatched. One species (*Odynerus parietinus*) has frequently been observed carrying off the smaller of these weevils, and another hymenopteron (*Cerceris arenaria*) often does the same.

Blackbirds and thrushes also devour them.

4, Whitehall Place, London, S.W.,
June, 1894.

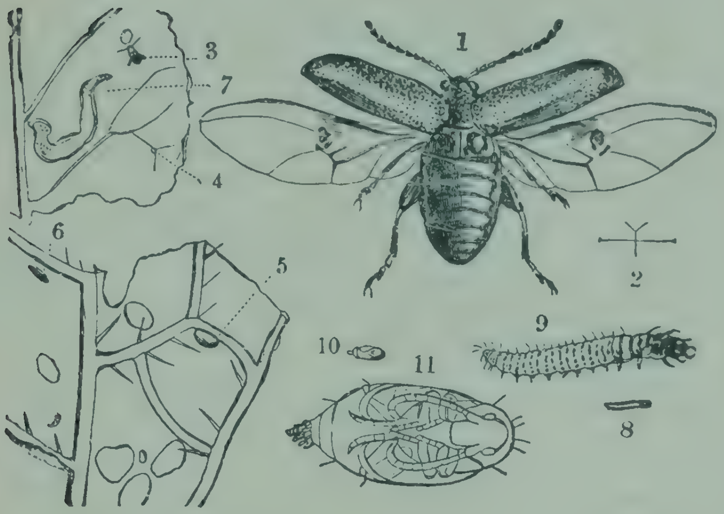
Revised, September, 1906.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 22 Leaflets dealing with Insect and other Pests of Fruit Trees and Bushes may be obtained from the same address, price 1*d., or* 9*d. per dozen copies, post free.*

BOARD OF AGRICULTURE AND FISHERIES.

"Flea" Beetles (*Halticae*).



1. The Turnip Flea Beetle, much magnified ; 2, nat. length and wing expanse ; 3, nat. size ; 4, 5, egg, nat. size and mag. ; 6, 7, mine, and cuticle eaten away by larva ; 8, 9, larva, nat. size and mag. ; 10, 11, pupa, nat. size and mag.

Flea beetles attack all manner of crops ; roots, cabbage, and hops being most harmed.

The Turnip Fly or Flea (*Phyllotreta nemorum*) and the Cabbage Flea (*Haltica oleracea*) are small beetles which thrive in dry, dusty, and cloddy soil, and in dry seasons cause much harm to turnip, cabbage, kale, and other plants, which cannot grow away from their attacks. Directly the seed leaves show, the young plants are eaten off, or, if they continue to grow, they are in most cases so weakened as to be practically useless. Other closely related species work in a similar way. In conditions favourable to the propagation of the beetles, they increase with great rapidity ; generation succeeds generation, clearing off every particle of growth as it appears. The beetles do not flourish in showery weather, and as this suits the turnip plants, it is chiefly in times of drought that most damage is done. In such seasons, turnips have often been sown three times, each crop being successively cleared off.

Though the main and most dangerous attack of these beetles is undoubtedly when the plants are just starting, and until they are fairly in the strong "rough leaf," it is by no means unusual in periods of drought to find that even if the

plants manage to grow away from the first onslaughts, they are so steadily and constantly beset by the insects, and their leaves are so much bitten, that they never make good roots. When the roots are formed, and are of some size, late generations of beetles pertinaciously stick to them, in some seasons even until September. The turnip flea-beetles not only attack turnips and swedes, but are sometimes destructive to rape, mustard, cabbage, kohl-rabi, and other cultivated cruciferous plants.

Quite as harmful, if not more so, is the Cabbage Flea (*Haltica oleracea*); in some districts it is the chief culprit, the so-called Turnip Fleas only appearing in small numbers. Whole cabbages may even be destroyed by the Cabbage Flea. Hops are often ruined by these pests, the young shoots and also the cones being invaded.

Description and Life History of the Beetles.

The Common Turnip Flea (*P. nemorum*) is very small, being only about one tenth of an inch long. It is black, bluish-black, or greenish-black in colour, with a broad yellow stripe down each wing-case. The antennæ are 11-jointed, the three joints nearest the head being yellow, the others dark-coloured. The legs are ochreous, or yellow, and the thighs, which are very stout, are well adapted for the long jumps which this insect can make. Like all flea beetles, it passes the winter in beetle form under clods and stones, in tufts of grass, among weeds, beneath the bark of trees, and under rubbish of various kinds, by the sides of fields, hedgerows, and ditches. It is thus sheltered during the winter, and it is sustained throughout the early spring-time, until the turnip seed has germinated, upon wild cruciferous plants, such as charlock, hedge-mustard, and wild radish. It has large and powerful wings, expanding to more than a quarter of an inch (Figs. 1 and 2), and takes long flights in search of congenial food, which it scents from a distance. In its feeding it shows a preference for the seed leaves, and for the plant in its youngest stages, *e.g.*, when the plant is most delicate and least able to withstand injury. The beetles lay their eggs on the under sides of the second or "rough" leaves. From these eggs, tiny yellow larvæ come in five or six days (Figs. 8 and 9), which, mining (Fig. 7) in the leaves, and feeding upon the soft tissues, greatly weaken the plants. When full grown, the larvæ are rather more than $\frac{1}{8}$ of an inch long, with six feet and a caudal proleg, or "sucker foot." In the course of from five to seven days, they fall to the ground and change to pupæ (Figs. 10 and 11), from which, in about 12 days, the perfect beetles come and proceed to attack the turnip-plants. It is said that as many as six generations may be produced in a season, if weather and other conditions are favourable.

P. undulata, an allied species, is often also very troublesome on the turnip crop ; it is slightly smaller than *nemorum*, and has dark-coloured legs.

The Cabbage Flea (*Haltica oleracea*) is often far more harmful than the Turnip Flea ; in some districts it is the chief root crop and general pest. It is of a deep bright bluish-green colour. This species feeds mainly on the upper side of the leaves, and attacks old and young plants, especially cabbages, but also turnip and other crops. Unlike the Turnip Flea, it does not make holes in the leaves, but eats the upper epidermis and soft under layers, leaving the lower skin intact. The female lays her eggs on the surface of the leaf, and the larvæ feed *upon* the leaf. When mature the larvæ pupate in the soil like the Turnip Flea. The beetles do not seek shelter so readily in inclement weather as the Turnip Flea, but remain upon the leaves of the plants. The great difference to be noticed here is that the maggots do not burrow into the leaves, so can be destroyed by arsenical washes. It is thus important to note which of these two common flea beetles is doing the damage.

Methods of Prevention and Remedies.

1.—Sowing upon a "stale furrow" is calculated to prevent the attacks of these beetles. A stale furrow usually implies a "good season," or a fine tilth or seed-bed, whereas fresh-ploughed land does not usually work down well, but is unkind and cloddy. Moisture also evaporates more quickly from land that is cloddy, or rough, than from fine tilthy soil. The beetles do not like moisture, and moisture naturally helps the young plants to grow away from their foes.

2.—Rolling the land after the drill should be adopted, as this assists germination and gets rid of clods underneath which the insects shelter.

3.—Artificial manure mixed with well-powdered ashes, or mould, may be drilled in with the seed so that it may be close to the plants to help them to grow as quickly as possible away from the onslaughts of the beetles.

4.—Putting in seed with a water drill has certain advantages on some soils where the beetles are known to be particularly troublesome. An objection to the water drill is that the moisture soon evaporates in a dry season, and though it starts the germination of the seed rapidly, this is liable to be checked and the vitality of the seed injured unless rain soon comes.

5.—Cruciferous weeds, such as charlock, encourage the beetles and furnish them with food until the turnip plants are ready for them. It is desirable, therefore, that charlock and other cruciferous weeds should be kept down.

6.—The destruction of winter shelter as far as possible is very important. Hedge bottoms should be cleared in winter, and the refuse burnt, and all refuse where these pests are

likely to pass the winter should be got rid of. Broken bine lying about in hop gardens should be collected and destroyed.

7.—In some seasons sowing mustard seed with turnip seed preserves turnip plants from serious injury, as it germinates and forms plants more quickly than turnip seed, but in very dry times, when the attack is virulent and generations of beetles follow rapidly, this has been found of little value. The beetles do not take to mustard plants in preference to turnip plants, but being ravenous, they attack the mustard plants, as they come up first.

8.—Seed should be soaked in paraffin or turpentine before being sown. The latter answers best, and is usually found to keep "fly" away from the seedlings for some little time, and may perhaps, apart from the beetle attack, produce an earlier and more vigorous growth. Mixing the seed with flowers of sulphur is also recommended.

9.—Paraffin oil may be distributed in very small quantities over the seedlings, so that each leaf is sprinkled and made distasteful to the beetles; for this special spraying machines must be used, so as to send out a fine dense spray. In a case where, experimentally, sand or sawdust steeped in paraffin was spread on the drills, not only were the young turnips more vigorous in their growth, but they were also protected against a small Ceutorhynchus beetle which attacks the seed-leaves before these get above the soil.

10.—Rolling infested plants, by disturbing the beetles, frequently proves serviceable, especially if the soil is cloddy.

11.—Pushing by hand a light wide framework upon wheels with well tarred boards fastened upon it, so as to come just over the plants, has been found to catch many beetles, which, being disturbed, jump against the tar. Many acres can be got over in a day by a horse pulling this machine, which should be made very light. The tar requires to be renewed as it gets dry, and the beetles, which accumulate in masses, must be scraped off. Cart grease may be used instead of tar.

12.—In the case of Cabbage Flea and other *Halticae* where the larvæ feed on the *outside* of the leaves, spraying with Paris green would be found successful by killing the larvæ; on the other hand, it would be useless for Turnip Flea, as the maggots feed within the leaves.

4, Whitehall Place, S.W.,
July, 1895.

Revised, July, 1905.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 4.

BOARD OF AGRICULTURE AND FISHERIES.

Winter Moths.

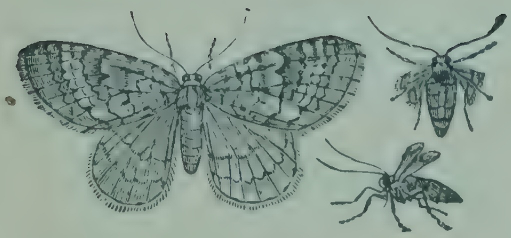


FIG. 1.

FIG. 2.

Fig. 1. Winter Moth (*Cheimatobia brumata*). Fig. 2. Mottled Umber Moth and Caterpillar (*Hibernia defoliaria*). Male Moth, winged ; Female Moth, wingless. All natural size.

There are several moths whose wingless females crawl up the stems of fruit and forest trees in the autumn and early winter and spring and deposit eggs in the interstices of the rind of the twigs and branches. From these eggs caterpillars are batched in the spring which bore into buds and eat the foliage and blossoms, and young green shoots, and, in conditions favourable to their development, cause much injury to the fruit crop. Among these moths the Winter Moth (*Cheimatobia brumata*) (Fig. 1), the Mottled Umber, or Great Winter Moth (*Hibernia defoliaria*) (Fig. 2), and the March Moth (*Anisopteryx aescularia*), are the principal offenders. In some seasons, especially in those when the progress of the leaves and blossoms is arrested by spells of cold weather, great mischief is caused by the caterpillars of these and other moths, the females of which are wingless. Sometimes the trees are left as bare as in winter, and are, besides, seriously injured for another season. The caterpillars attack apple, plum, damson, filbert and cob-nut trees, and occasionally currant and gooseberry bushes that are set under apple and plum trees in fruit plantations. They are also harmful in woods, feeding on the hazel, maple, hornbeam, lime, oak, hawthorn and blackthorn.

Description and Life History.

About the second week of October, the two Winter Moths come from chrysalids in the ground, under and near the trees that were infested with caterpillars in the preceding summer, and the wingless females crawl up the trees for the purpose of egg-laying.

The Moths.—The male of the Winter Moth measures 1 to $1\frac{1}{4}$ inches in spread of fore-wings. These are grey-brown in colour with darker wavy lines. The hind wings are pale grey and are without markings.

The female moth has the wings so small that flight is impossible. The abdomen of the female is large and the legs long.

The Mottled Umber is about twice as large as the Winter Moth. The male has the fore-wings pale brown or brown-yellow, each with two dark bands. The hind wings are paler and have a brown spot near their middle. Small dots show over the wing surface.

The wings of the female are practically abortive; the brown body has two dark spots on every segment.

The antennæ of the male are combed, those of the female simple.

The moths of both these species begin to appear in the first week in October, and may be seen throughout November and December, and even in January and February—depending on the weather.

The March Moth has a brownish head. The fore-wings are brown or yellow-brown with transverse bands; the hind wings are pale greyish-white with a darker zig-zag line running across them. The moth measures about three-eighths of an inch in length and up to $1\frac{1}{2}$ inch in spread of wings. The female is wingless, brownish-yellow, and has a pencil or tuft of hairs at the hind end.

The March Moths appear typically, as the name indicates, in March, but they may be found earlier.

The Eggs.—The eggs of the Winter Moth are very small, cylindrical, and at first of a light green colour, afterwards becoming red. They are placed in small groups, usually at the base of buds and on pruned surfaces, sometimes in the chinks of the rind of the branches and shoots, and fastened there with a sticky substance. From 150 to 200 eggs are laid by one female. The Mottled Umber Moth lays larger, rather rusty coloured, long eggs, and more in quantity (as many as 400), which are placed in lines, or small groups, according to circumstances. The eggs of the March Moth are laid round the twigs in bands or rows, and embedded in the down or hairs from the hind tuft of the female.

The Caterpillars.—From the eggs the caterpillars come in the early spring, usually about the middle of March, and, as it appears, just before the buds begin to burst. The Winter Moth caterpillars are at first grey, with dark heads, and so small that it is difficult to see them. Later on they become greenish, with white stripes and brown heads, and are finally rather yellow. When full grown they are about three-quarters of an inch long. They, as well as those of

the Mottled Umber and March Moths, are called "loopers," or "measurers," on account of the position they assume when moving. They have six true legs, and only two pairs of prolegs, one pair of these being at the hind end of the body, so that they can be easily distinguished from caterpillars of moths of other families. These larvæ eat bud, leaf, blossom, and fruit, and spin the blossom heads, and also the leaves, together, and live under their protection. When food fails, or when they are fully fed,—from May to June—they let themselves down by silken threads to the ground, in which they bury themselves.

The caterpillar of the Mottled Umber Moth is chestnut brown in colour, with a wavy dark stripe on each side of the brown ; there is a tinge of yellow on the under part of the body. It is much larger than the Winter Moth caterpillar, being 1¼ inches in length (Fig. 2). These caterpillars, too, have the habit of letting themselves fall from the twigs, to hang by a silken thread. When the period of pupation arrives the caterpillar descends to the ground and changes to a chrysalis just below the surface.

The caterpillar of the March Moth is yellowish green, with a darker green line down the back edged with yellow; there are pale yellowish lines at the sides. The pupal stage is passed in the ground.

Methods of Prevention.

1.—It is very necessary to adopt methods of prevention against these insects. The first and most important measure is to prevent the wingless female moths from crawling up the trees in the autumn and winter months. This can be effected by putting sticky compositions round the stems to entrap the moths.

Cart grease made from fat or oils, and without tar, is recommended as the best and safest composition to use for banding fruit trees. In all cases the grease must be spread on bands of grease-proof paper. These bands should be 6 or 7 inches wide, and tightly tied to the tree above and below by string. The upper string should not be tied at the extreme top of the band, but from two to three inches below. The grease should then be applied rather thickly above the upper string. Any tendency of the grease to run is then largely prevented by the support afforded by the string. The operation is completed by drawing the fingers through the grease on the band in such a way that horizontal ridges are left round the band. The ridges will keep the grease band "tacky" for a much longer period than if the grease be applied in a thin layer by means of a brush.

The bands are, on the whole, best placed 4 or 5 feet above the ground. It has been observed that numbers of eggs are laid by the females in the crevices and bark below the bands.

A band about 1 foot from the ground would result in a smaller number of eggs being laid below it and consequently in a smaller number of caterpillars being hatched. The risk of attack is therefore reduced if the bands did not happen to be sufficiently sticky to prevent caterpillars ascending the tree. On the other hand it is possible that females may be carried by the male over a low band. Experimental evidence has shown that other injurious insects are caught in the bands placed primarily against the Winter Moth and its allies.

If the trees are young and stakes are used, the stakes should be greased also, but paper is not necessary for the stakes.

Grease-banding must be commenced not later than the end of the second week in October, and the grease must be renewed from time to time before the previous application has become dry and hard. With a good grease three applications should be sufficient, the first in October, the second probably in December or when the first shows signs of drying, and the third about the middle of March. The last application serves to catch the March Moth, and at the same time to stop the caterpillars of the Winter Moth (which have hatched from eggs laid below the grease band) from ascending the trees. If stout paper be employed the bands may be used for two years. With young trees there is risk to their health from the bands being left all the year round, but with older trees the bands may be left, and if greased at intervals may serve to catch other insects.

It is important to keep the bands in good working order as long as moths are seen about.

2.—In the case of cultivated fruit land, many of the chrysalids might be destroyed by digging or hoeing late in the summer the ground all round trees that were infested in the spring, and by digging or hoeing in lime or gas-lime.

3.—In grass orchards, the herbage should be close-fed off by sheep. Poultry should always be kept in orchards, for they devour many larvæ, and also the female moths as they escape from the ground. Many fruit growers also recommend pigs, which help to keep the trees in a comparatively clean state by destroying insects in the ground.

Remedies against the Caterpillars.

To destroy the caterpillars spraying trees with arsenical washes is necessary. Small apple, plum, and damson trees, filberts, cobs, and fruit bushes can be easily sprayed by means of proper knapsack sprayers. Large trees beyond the reach of hand sprayers can be sprayed with hop-washing machines, but there are machines especially manufactured for this purpose.

Only arsenical sprays are of any use against the caterpillars. Two of these sprays can be recommended, viz., arsenate of lead and Paris green.

Arsenate of lead, which is recommended as preferable to Paris green, should be bought in the paste form.

Paris green should also be bought in the paste form. The formula for employing it is:—

Paris green	...	...	5 to 10 oz.
Quicklime	...	...	10 oz.
Water ...	...	...	100 gals.

As Paris green does not dissolve in water the mixture must be kept constantly agitated so that it may be maintained of an uniform strength.

It is not advisable to spray with arsenical solutions when the trees are in blossom, unless the attack is very severe, or bees may be killed and blossom destroyed. As the object is not to dislodge the caterpillars, but to poison their food, the arsenical solutions should be made to fall like gentle mist upon the leaves, fine spray jets being used for this purpose.

Live stock may be kept in orchards where arsenical compounds have been used. Such compounds, however, must not be used where gooseberries for early picking, and herbs and vegetables for early use, are grown under the trees.

4, Whitehall Place, S.W.,
September, 1895.

Revised, October, 1910.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 22 Leaflets relating to Insect and other Pests injurious to Fruit Trees and Bushes may be obtained from the same address, price 1d., post free.

Leaflet No. 5.

BOARD OF AGRICULTURE AND FISHERIES.

Mangold Fly (*Pegomyia betæ*,* Curtis).

1. Male, magnified.
2. Male, natural size.
3. Female, magnified.
4. Female, natural size.
5. Larva, natural size.
6. Larva, magnified.
7. Pupa, natural size.
8. Pupa, magnified.

Serious injury is often caused to mangold plants in June and July by the attacks of the fly, *Pegomyia betæ*, whose larvæ, or maggots, form burrows within the tissues of the leaves, and live upon the juices, weakening and exhausting the plants, and sometimes killing them. After the mangold plants have been singled and begin to show vigorous growth, they sometimes suddenly droop and present a withered appearance. Upon examination, it will be found that there are pale blotches, like blisters, upon the leaves, caused by maggots lying within their tissues, from which they have exhausted the juices. These discoloured patches become brown and withered.

Description of Insect.

The fly is about the size and shape of a common house fly. It is dark ashy grey, with black bristly hairs. The under surface of the abdomen of the male has four black triangular basal spots in the middle of four segments; the female has three indistinct stripes along it. The legs are bristly. The femora (thighs) of the female are yellow, as are also the tibiæ, or middle joints of the legs, in both sexes.

The egg is oval, white, and covered with six-sided markings.

The larva or maggot is about a third of an inch long, with undefined, or indistinctly marked segments. In colour it is

* Formerly called *Anthomyia betæ*.

creamy white, somewhat transparent, so that the green food in the intestinal canal is visible. It has no legs. Its tail end is cut square, but the head is sharp pointed, and furnished with a pair of hooked appendages which serve for boring and cutting into the tissues of the leaves.

Life History.

The fly is seen from March to June. The female deposits her eggs singly, or in groups of two, three, or four—rarely more—upon the under surface of the leaves of the mangold plants as soon as they appear above ground. When two or more eggs are laid together they are placed side by side.

Maggots come out from the eggs in about five days, and immediately bore their way through the epidermis into the central leaf tissue, on which they feed.

The maggot stage continues for about a month, and during this period the insect does active mischief. Pupation is assumed either in the leaves, in which case the red, or reddish-brown, puparia may be seen embedded in the blisters caused by the maggots; or the maggot falls to the ground and pupates therein. From these early puparia the flies emerge in about ten days.

There are two broods during the year. The maggots of the second brood become pupæ in the ground, or in decaying leaves and similar material, and in this puparium stage the winter is generally passed. From these puparia the first brood of flies issues in the spring.

Remedies.

1.—In the first place, infested plants should be top-dressed with nitrate of soda and common salt, put on at the rate of from 1 to 1½ cwt. of nitrate of soda and 2 to 3 cwt. of salt per acre. This will force them on and give them a chance to grow away from their enemies.

2.—Washing the plants with an emulsion of paraffin oil and soft soap and water has been adopted with some success. This is made by mixing paraffin and soft soap together in the proportion of 1 gallon of paraffin and half a pound of soft soap to 10 gallons of water, thoroughly incorporated by means of a hand-pump or syringe. This composition can be put on by means of a horse-machine for the distribution of liquid dressings in the form of spray. A knapsack-machine would be found useful for applying liquids in the case of small holdings.

When the eggs are discovered upon the leaves of mangold plants in infested fields, it would probably do good to apply paraffin and soft soap washes at once to make the foliage unpleasant to the maggots when they are hatched, and thus prevent them from burrowing into the leaves.

3.—Where some of the plants in mangold fields are very seriously attacked, exhibiting many blisters and blotches, they should be pulled up and destroyed, so as to prevent a second brood of flies from being hatched and spreading further mischief. Where the plants are less affected the leaf-blotches only may be removed and destroyed. Women or children could do this work, but they would require careful instruction and direction. It need hardly be said that the plants pulled up must be completely destroyed, either by burning them or by putting the leaves in pails of hot lime.

Prevention.

a.—All the leaves of mangold plants in infested fields must be carefully collected and destroyed after the roots have been lifted. On no account should the leaves stripped from infested crops be taken into pastures for cattle during the summer, as is sometimes the custom.

b.—Many weeds, as some of the thistles (*Carduus*), sow-thistles (*Sonchus*), dandelion (*Taraxacum*), and "Fat Hen" or "Goosefoot" (*Chenopodium album*), upon which the eggs of this fly are frequently found, serve as harbours for this insect, and should be kept from the neighbourhood of mangold fields.

c.—In some localities dock leaves are frequently full of the maggots of a *Pegomyia*, which appears to be *Pegomyia betæ*, and it would be wise to wage war against this weed, and to cut it up at once.

4, Whitehall Place, London, S.W.,
January, 1898.

Revised, October, 1905.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

VOLES AND THEIR ENEMIES.*

Among the vermin whose excessive multiplication, under especially favourable circumstances, results in injury to farmers, the field vole has several times been conspicuous, and it was particularly so in 1892, when it inflicted extensive damage on young grass and herbage, on hill grazings and rough pastures in southern Scotland. This animal has also proved a source of much loss on other occasions in various parts of the country, as in Essex and Kent three hundred years ago, in Gloucester and Hampshire early last century, and again in Scotland in 1875-6.

The animal which caused so much mischief on many hill farms in the southern uplands of Scotland in 1892, although often spoken of as a mouse, is technically known as the short-tailed field vole (*Microtus*, formerly *Arvicola*, *agrestis*) (PLATE I.). Two species of the genus *Microtus* inhabit this country, viz., the water rat (*M. amphibius*) and the field vole (*M. agrestis*). The red or bank vole (*Evotomys glareolus*) belongs to another genus.

All three voles are distinguished from the true mice (genus *Mus*) (PLATE II.) by their stouter body, thicker head, blunt muzzle, small ears, and the tail shorter than the body, whence they are often called short-tailed mice. Their molars, or back teeth, have flat crowns, with transverse ridges of enamel, adapted for grinding the vegetable matter on which they feed, whereas in true mice they are covered with points or tubercles suitable for an omnivorous diet.

The Short-Tailed Field Vole (*Microtus agrestis*).

This vole is at all seasons an inhabitant of our pastures, and may be found at all heights, from the sea level to near the summits of our highest hills; its favourite haunts, however, are low-lying moist grass lands and damp plantations, especially when young. In such spots, and more frequently in the former, these animals live in communities,

* The illustrations, together with the notes on which this leaflet is based, have been taken from the Report of the Departmental Committee on Field Voles (Scotland), C. 6943.

forming numerous burrows at a considerable depth, each pair having their own dwelling in which they bring up their young, and deposit their store of winter food. All around, their tortuous runs are seen on or near the surface, indicating where they have been foraging.

The characteristics of the field vole (PLATE I.) are a blunt rounded muzzle, short ears, and a short hairy tail. These features distinguish it from the true field mouse, or long-tailed field mouse (PLATE II.), which has a pointed muzzle, prominent ears, and a long naked tail.

The field vole usually produces three or four litters a year, each consisting of from four to eight young; in some seasons, however, it is even more prolific, the breeding season being prolonged from February to November, and the litters containing as many as ten young.

Its diet is principally herbivorous, consisting of grass, the roots of young broad-leaved trees and conifers, and the tender bark of trees and shrubs. It particularly affects the delicate white stems of grass but in times of scarcity nothing green comes amiss to it. Insects and worms are also eaten; in connection with the destruction of Larch by the caterpillars of the Large Larch Sawfly this vole has been found destroying the cocoons and eating the caterpillars.

The Water Vole or Water Rat (*M. amphibius*).

The water vole devours the stems of grain, grasses, &c., growing near water, and also barks the exposed roots and bases of stems of shrubs and trees, osier beds for example being sometimes much harmed. The water vole also damages the banks of rivers, canals, and dykes. It lives along the borders of streams or almost any piece of water, also in damp meadows, and tunnels long passages into the soil. It is blackish-brown on the back, while the belly is greyish-brown or black. Its length is 6 inches. The water rat differs from the common brown or Norway rat in having a rounded muzzle, short ears, and a short hairy tail.

The Bank Vole (*Evotomys glareolus*).

This vole occurs chiefly in and around forests and woods, being especially fond of sheltered banks, ivy-clad tree stumps, and the exposed roots in banks. Not infrequently it does considerable damage to trees. It climbs to the height of ten feet or more, and eats out the terminal and lateral buds, its action resulting in the formation of misshapen stems. The bank vole is brownish-red with a pure white breast, belly, and feet; the ears are longer than in the field vole, coming well above the fur. It varies in length from $3\frac{1}{2}$ to 4 inches, while its tail reaches $1\frac{3}{4}$ inches. It is not difficult to catch by means of traps baited with cheese.

Natural Enemies of Voles.

Most of the animals described as preying upon the field vole are likewise natural enemies of mice and rats. Thus weasels, stoats, foxes, rooks, crows, ravens, sea-gulls, kestrels, owls, and buzzards are all known to prey upon these vermin.

*Short-Eared Owl.**—This bird (*Otus brachyotus*) is one of the greatest and most effective enemies of the field vole. It is distributed over almost every part of the globe, and is a normal winter immigrant to these islands, appearing simultaneously with the woodcock (whence it is popularly known as the "woodcock" owl) and usually departing in spring. Nests in ordinary seasons are of comparatively rare occurrence in Great Britain, but on occasions when there has been a multiplication of their favourite food, the vole, these owls (PLATE III.) have not only arrived in unusual numbers, but have remained and bred all over the affected district, laying from 8 to 13 eggs, and rearing more than one brood. Professor Newton, however, in his edition of Yarrell's "British Birds," mentions seven as an unusual number of eggs, and five seems a general clutch.

The short-eared owl differs from most other owls in that it hunts in daylight—hence one of its names "Hawk" owl—so that its beneficial operations can be observed, but the nocturnal species are no less beneficial to farmers in destroying small rodents, and it would be difficult to condemn too severely the foolish and cruel action of those who encourage or allow the destruction of this useful and beautiful family of birds.

The Kestrel.†—Next, and hardly inferior in merit, as a check upon voles and mice, comes the kestrel (*Falco tinnunculus*) (PLATE IV.), and it is to be deplored that popular ignorance as to its food and habits is even greater than that which prevails in regard to owls. This bird, although possessing the long wings and dark eyes characteristic of a true falcon, is known to gamekeepers as "a hawk," and its death warrant is a standing order in some preserves, though here again there has been great improvement, and the destruction of the kestrel is forbidden on many estates. The food of this bird is known to consist chiefly of voles, mice, and insects.

It is one of the peculiarities of the *Falconidæ* that their plumage varies according to their age and sex; in the southern counties of Scotland the sparrow-hawk (PLATE V.), which does not prey on mice, is generally known as the "blue hawk," and the kestrel as the "brown" or "red"

* *See also* Leaflet No. 42 (*Short-Eared Owl*).
† *See also* Leaflet No. 40 (*Kestrel or Wind-hover*).

hawk. But an immature male sparrow-hawk has reddish-brown plumage, and an adult male kestrel has a bluish-grey head and back. The Kestrel is also characterised by its habit of poising or hovering, so that for many minutes its position in the air is practically stationary.

Other Birds.—Buzzards and *ravens* destroy voles and mice, and are too heavy on the wing to do much injury to game. *Rooks* and *crows* have also been known to dig up the nests of voles and mice, and to devour the young. Certain species of *sea-gulls* have also been observed to prey on voles.

Stoats and Weasols.—These little animals are among the deadliest and most persevering enemies of small rodents. They kill far more than they can devour, apparently out of sheer blood-thirstiness. In woodlands and on low ground they undoubtedly do much harm to game, especially the stoat (PLATE VI.), which may be easily distinguished from the weasel (known in Scotland as the "whittret," PLATE VII.) by its greater size and by the black tuft on the end of the tail, which is retained at all seasons of the year, even in winter, when the rest of the body becomes wholly or partially white.

It is, perhaps, hardly reasonable to expect that stoats should be allowed to multiply in game-coverts, or in the vicinity of pheasant coops, but the Board have no hesitation in recommending that weasels, which are persistent mouse-hunters, and do little damage to game, should not be molested, at least in moorlands and hill pastures, where they can do little harm and much good.

The natural enemies of the vole may be divided into two classes: (1) those which destroy voles and are harmless to sheep, crops, and game, and (2) those which, though preying on voles, are so harmful in other ways as to have less claim to preservation:—

1. *Vole-killers, harmless, or nearly so, to sheep, crops, and game:* Owls of all sorts, buzzards, kestrels, and the smaller sea-gulls.
2. *Vole-killers, harmful in other ways:* Stoats, weasels, ravens, carrion and hooded crows, rooks, and great black-backed gulls.

Strict injunctions should be given by landowners that the birds mentioned in the first class should not be destroyed. Their presence in full numbers, though inadequate to avert an outbreak of voles, would undoubtedly tend to mitigate it, and, as has been proved in the case of the short-eared owl, they have the faculty of multiplying abnormally in presence of an unusual supply of food. They are, at all events, most useful allies to man in combating attacks of ground vermin.

The use of the pole-trap is illegal.

Protective Measures.

With reference to the steps which may be taken by occupiers to protect themselves in the earlier stages of an outbreak, it is of great importance that early information be given to the local organizations, farmers' clubs, or agricultural societies, and to all interested, of the first signs of any exceptional multiplication of voles. Systematic and concerted attempts should then at once be adopted to stamp out the plague throughout the affected district. The most effective measures appear to be the periodical and timely burning of grass or heather, followed by active pursuit of the vermin by men with wooden spades and dogs. Where plantations of limited extent are attacked, pit-falls, wider at the bottom than at the top, and about 18 inches deep, have been found efficacious in trapping many voles.

4, Whitehall Place, London, S.W.
July, 1893.
Revised, February, 1912.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, *Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.*

A pamphlet containing 11 *leaflets dealing with Wild Animals and Birds may be obtained from the same address, price* 1d., *or* 9d. *per dozen copies, post free.*

PLATE I.

SHORT-TAILED VOLE. *Microtus*, formerly *Arvicola, agrestis.*—Locally known as Field Vole, or Grass Mouse, and Meadow Mouse. Colour, reddish-brown above, paler beneath. Average length of head and body, 4 ins.; tail, 1 in. External

LONG-TAILED FIELD MOUSE. *Mus sylvaticus.*—Colour, sandy-brown above, white beneath. Average length of head and body $4\frac{1}{4}$ ins. ; tail, 4 ins. External distinguishing characters : long pointed muzzle, prominent

Plate III.

SHORT-EARED OWL. *Otus brachyotus.*—Migratory, living much on the ground, and of diurnal habits. General colour, yellowish-brown above, variegated with spots, streaks, and cross-bars of a darker colour ; pale beneath. Eyes yellow. (The eyes of the White or Barn Owl and the Brown or Tawny Owl are black.) Appears usually in October (whence called Woodcock Owl) and remains until April. A few remain to breed annually in suitable situations. Preys largely on mice and voles.

PLATE IV.

KESTREL or WINDHOVER. *Falco tinnunculus.*—Locally known as the Brown or Red Hawk. A long-winged, dark-eyed Hawk, with reddish-brown back and bluish-grey head and tail when adult. Preys upon mice, voles, beetles, grasshoppers, small birds, and occasionally young game-birds. Easily recognised on the wing by its habit of hovering over the fields.

PLATE V.

SPARROWHAWK. *Accipiter nisus.*—Locally known as the "Round-wing" or "Blue Hawk."—A short-winged yellow-eyed Hawk with long-barred tail. Mottled brown above when young, brownish-grey when adult. White beneath, with transverse bars on breast and flanks. Preys upon small birds, black-birds, thrushes, pigeons, and young game-birds. Does not hover like the Kestrel.

PLATE VI.

STOAT. *Putorius ermineus*, formerly *Mustela erminea.*—Locally known as Weasel, Stoat, Clubster, Lobster, and Ermine (in winter). General colour, brown above, white beneath. Tail longer than in Weasel, and with a black tip at all seasons, even in winter, when the fur becomes white or partially so. Average length of head and body, 9 to 10½ ins.; tail 4½ to 6 ins. Preys on mice, voles, rats, rabbits, leverets, and young game-birds.

PLATE VII.

WEASEL. *Putorius nivalis*, formerly *Mustela vulgaris*.—Locally known as Whittret, Cane, and Mouse-hunt. Average length of head and body, 7 to $8\frac{3}{4}$ ins.; tail, 2 to $2\frac{1}{2}$ ins. Colour, reddish-brown above, white beneath; tail, brown. Does not turn white in winter. A persistent enemy to rats, mice, and voles. It also takes rabbits and leverets.

BOARD OF AGRICULTURE AND FISHERIES.

Autumn Catch Crops and Fodder Supply.

The Board of Agriculture and Fisheries believe that it may be useful to direct the attention of farmers and others to special and catch crops, which, in the event of an early harvest, may, under favourable conditions, prove of utility in providing green food for stock in the succeeding autumn, winter, and spring in districts where severe and prolonged drought has seriously diminished the ordinary hay and fodder crops of the season.

The policy of resorting to one or other of these catch crops must in every case be determined by the varying local circumstances of soil and climate, and cannot be made the subject of general recommendation.

It cannot be too strongly emphasized that more attention might usefully be given to green fodder and catch crops as a provision against possible drought and hot summers. Such crops need never be wasted ; when not absolutely required for fodder in the green state they can almost invariably be ensiled and held in reserve for winter use.

Rye, if sown by the middle or end of July, might afford good food for stock early in the autumn, or it might be mown for hay if the land were strong and in good heart. It would furnish very early food for stock in the spring, or it could be made into silage. Rye in the early stages of its growth should be top-dressed freely with nitrate of soda.

Oats put in in July would give food for soiling or cutting in the autumn. The crop might also be made into hay, and it is equally useful for converting into silage.

Trifolium incarnatum on suitable soils and under favourable conditions, in its three varieties, early, medium, and late, may be largely sown in proper proportions to follow in succession in cutting. It may be sown on stubble directly the cereal is off, while it might also take the place of red and other spring-sown clovers that have failed.

Italian Rye Grass sown very thickly in July or August, would under favourable conditions yield some good food in the autumn, and again in the following spring. This crop provides good fodder for dairy stock. It may be sown after vetches or grain crops from July to September, but will require a heavy manuring of nitrate of soda or other nitrogenous fertiliser.

Trifolium pratense, or Red Clover, when sown by the first or second week in July, either alone or with Italian rye-grass, might with sufficient moisture yield a good crop in the autumn. It should be simply brushed or rubbed in, or harrowed in by a chain harrow, followed by a roller. Nitrate of soda and superphosphate may be used as manures. This clover can only be mown once, but it affords excellent feed throughout the late summer and autumn after its crop of hay.

A mixture of *rapid growing Grasses and Clovers*, such as red clover and Italian rye grass, with the addition of cocks-foot, trefoil, and alsike, should, with the necessary moisture, yield a good crop by the end of September, or in October, when sown by July.

Brank, or Buckwheat, may in some instances be grown with advantage, where climate and soil permit. It grows rapidly, may be sown up to the end of July, and suits poor dry light soils.

White Mustard grows very rapidly, and may be sown where turnips and mangolds have failed, or upon stubble. If plenty of seed be used, and some phosphatic manure be applied to the stubble, there should be good sheep food in six weeks or less, but this crop does not stand a hard winter. A peck of seed per acre, sown as late as the end of August, will yield good food by the end of November.

Rape, in the form of Giant Rape, may be drilled in the old drills where mangolds and swedes have failed, or on freshly ploughed stubbles. In a favourable season there might be time to single it and get a good crop, or it might be left unhoed.

Dwarf or ordinary rape may be sown broadcast in July and August on land where crops have failed, and should be harrowed in. On stubbles it may be sown broadcast with 3 or 4 cwt. of superphosphate per acre, and will furnish good food for the spring.

Thousand-headed Kale, when drilled in July or August, well manured, and afterwards singled, will under favourable conditions supply a valuable and very bulky food for both sheep and cows in early spring from February onwards. If kale plants are available time would be saved by their being transplanted where other crops have failed.

Thousand-headed Kale has, in many districts, taken the place of rape, as it yields a heavier crop.

Kohl-rabi may be put in up to the end of July where turnips and mangolds have failed, and where turnips could not be again sown, but in most districts the season would be too much advanced for a large crop to be looked for.

Vetches, sown after an early cereal crop, where the stubble has been broken up either by a plough, grubber, or harrow, might afford much food, even in the late autumn, on well farmed land. The seed should be sown with oats, wheat, beans, or rye to support the vetches.

Winter Oats and Barley, if put in before the end of July, may furnish a fair yield of food for soiling or ensilage. If the weather is unfavourable to quick growth these crops will still furnish excellent food for stock in the spring.

Pea Haulm, if made into hay, should form a useful addition to the stock of fodder for winter feeding.

Hop Bines may also be made into hay. For this the finer bines, which are often trained on cocoanut fibre strings, may be specially used, but care must be taken to pull out all strings so that they are not eaten by cattle. In making hop bines into hay the bines must be got together directly they are "hayed," and not left till the end of hop-picking. It will pay to take up the bine-hay when ready ; the neglect to take this precaution is the probable cause of the hop-bine hay frequently turning out poor.

Late Swedes, Turnips, &c.—Where mangolds and swedes have failed to come up, it would not be too late up to the end of July to run in the same drills, either with or without manure, some of the late and hardy varieties of swedes and turnips, six weeks turnip, or the grey stone turnip. There are several varieties of turnips which might be sown late in this way which would produce considerable quantities of keep, and stand the winter, even where sown broadcast, and some of them may be sown upon stubbles, after an early harvest, when they would have nearly three months to grow in.

Brewers' Grains will form a useful addition to rations of straw for stock in the absence of hay.

Clover Leys (Old Leys), instead of being ploughed up in the autumn, after a hot, dry summer, may often be left down for another year in cases where the plant is at all good.

*Ensilage.**

The process of preservation by ensilage, either in pit or in stack, is applicable to all kinds of green food, such as *Clover*, *Vetches*, *Rye*, *Oats*, *Wheat*, *Peas* and *Beans*.

Silage may be either sweet or sour, according to the pressure employed. In sweet silage the material is allowed to heat to a higher temperature than in the other form.

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* *See* also Leaflet No. 9 (*Ensilage*).

Sorghum Saccharatum, drilled or dibbled in not later than the second week of July would, in a hot summer, yield a bulky crop suitable for ensilage. If, however, the late summer should prove cold or wet, the crop is unlikely to prove successful.

Maize, or Indian corn,* will yield a crop large enough for ensilage when sown up to the end of July in the southern counties. When sown late the seed should be previously soaked to ensure rapid germination.

Great care must be taken in converting maize or sorghum into silage, as both are apt to become mouldy.

Refuse herbage.—Rough herbage on the outside of fields, by the sides of hedges and roads, &c., should be mown and put into silos with any brushings of meadows and pastures.

Coarse Hop Bines may be chopped while green and put into the silo, care being taken to remove all cocoa-nut fibre strings.

Aftermath.—Pastures and meadows not wanted for stock may be treated in July and August with nitrate of soda, and would yield herbage, if not for hay, at any rate for ensilage late in the autumn.

Fern or Bracken may be made into hay, or put into the silo.

The green shoots of *Gorse* or *Whin* may be made use of for spring food in districts where these are available.

In the special circumstances of an abnormally hot season it may be also expedient with the view of providing sufficient supplies of fodder, to use straw for the feeding of stock, wherever practicable, and to substitute for bedding, such materials as fern or bracken, moss litter, and rushes.

4, Whitehall Place, London, S.W.,
July, 1893.
Revised, August, 1911.

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* *See* also Leaflet No. 73 (*Cultivation of Maize for Fodder*).

BOARD OF AGRICULTURE AND FISHERIES.

Assessments to Local Rates.

The Board of Agriculture and Fisheries have, on more than one occasion, found it useful to circulate a memorandum, prepared by the Local Government Board, directing the attention of occupiers of land in England and Wales (outside London) to the principles upon which assessments should be made to the poor rates and other local rates, and explaining the steps which may be taken, where an assessment is objected to, to obtain a reduction of the amount on the ground that their premises have been valued at too high a figure, or the valuation maintained at a level above the actual value.

It has been thought desirable to incorporate in that memorandum, in addition to the primary subjects dealt with, a reference to the bearing of the Agricultural Rates Act, 1896, whereby special and important provisions relating to the assessment of agricultural land have been enacted. The Act was originally made to operate for a period of five years commencing 1st April, 1897, but it has now been continued in force until the 31st March, 1910. The Board would also draw the attention of owners and occupiers of land to Sections IV. and V. of the memorandum, concerning the rating of woodlands and plantations, and of sporting and fishing rights.

Memorandum.

Outside London the basis for the assessment of the poor rate, and practically of every other local rate levied under the general law, is, where the Union Assessment Acts are in force, the valuation list made under those Acts. The only places in England and Wales, outside London, where the Union Assessment Acts are not in force are a few large town parishes under local Acts.

I.—*As to the Poor Rate.*

Where the Union Assessment Acts are in force, the poor rate is assessed upon the net annual, or rateable, value of premises, as entered in the valuation list. The rateable value is arrived at by making certain deductions from the gross estimated rental of the premises, which is the rent at which the property might reasonably be expected to let from year to year, if the tenant paid all usual tenant's rates and taxes, and tithe rentcharge, if any. It is not necessarily the same as the rent actually paid for the property. By the Tithe Act, 1891, the liability for the payment of tithe rentcharge was imposed on the owner of the land subject to the tithe rentcharge, but it would seem that the gross estimated rental of the land is still to be calculated upon the assumption that the tithe rentcharge will be paid by the tenant of the land. The amount of the tithe rentcharge payable upon any lands, if not within the tenant's knowledge, may be ascertained by an inspection of the tithe apportionment deposited in the parish.

The deductions to be made from the gross estimated rental in order to arrive at the rateable value, are the probable average annual cost of the repairs and insurance, and any other expenses that may be necessary to maintain the property in a state to command a rent equal to the gross estimated rental.

If a person considers that his assessment to the poor rate is too high, he should, in the first place, give notice to the assessment committee and, desirably, to the overseers also, that he objects to the valuation list on which the rate is based. The notice must be in writing, and must specify the grounds of the objection. It may be served on the assessment committee by being left at the office of the clerk to the guardians, or sent by post addressed to the committee at such clerk's office, or delivered personally to the clerk of the assessment committee (usually the clerk to the guardians) or at his usual place of abode.

A day will be appointed by the assessment committee for the hearing of the objection, and on such hearing the committee have full power to call for and amend the valuation list. If they do amend it, they must give notice of the amendment to the overseers, who are thereupon to alter the poor rate current at the date of the notice of objection; so that, if on the hearing of an objection made by a farmer or other person the assessment committee reduce the assessment, the objector will only be called upon to pay on the reduced amount the rate current at the time when he made his objection. The reduction will take effect also as regards any rate made subsequently.

Supposing that the objector fails to obtain from the committee the relief to which he considers himself entitled, the only course open to him is to appeal against the poor rate to the next practicable special or quarter sessions. He cannot appeal against the rate unless he has first objected to the valuation list in the manner above referred to, and has failed to obtain relief from the assessment committee. An appeal to special sessions can only be made on a question of value, and does not lie where the dispute is as to the liability of a hereditament to be rated.

If the objector appeals against the poor rate he must give 21 days' notice in writing previous to the holding of the sessions to which the appeal is to be made, of his intention to appeal, and the grounds thereof, to the assessment committee. Notice is also required to be given to the overseers, and in some cases to the parish council, or to the town or urban district council. The objector should take legal advice as to the precise procedure in conducting such an appeal.

The justices on the hearing of an appeal against the poor rate are empowered to amend the rate by altering the sum therein charged on any person, or in any other manner which may be necessary for giving such relief as they think just; and in certain cases they may quash the rate. If the rate is amended, the valuation list must be altered by the assessment committee in conformity with the amendment made by the justices.

If the decision of the justices in special sessions is against the appellant, he may carry the appeal to quarter sessions. But in the vast majority of instances in which persons who have been over-assessed take action in order to get their assessment reduced, no appeal against the poor rate is necessary: the relief desired is obtained by the simple process of objection to the valuation list before the assessment committee.

With respect to places outside London in which the Union Assessment Acts are not in force, it may be stated generally that subject to the provisions of any local Act, the procedure for obtaining a reduction of assessment is by appeal against the poor rate to special or quarter sessions.

II.—*As to Rates other than the Poor Rate.*

The principal rates other than the poor rate which are levied under the general law, are the borough rate, the general district rate, the lighting rate, separate rates to meet contributions required by the county council, and separate rates levied for sanitary purposes in rural districts.

When the whole parish is liable to county contributions or to the borough rate, the sum required is usually paid out of the poor rate. Where only part of the parish is liable, a separate rate is levied in such part in the same manner as the poor rate, and the same observation applies to sums required for the expenses of burial boards. All these rates are based practically on the valuation list; and it would seem that if the assessment committee amend the valuation list after hearing an objection to the list, any of these other rates should be correspondingly amended without any formal appeal against the rate.

As regards the general district rate levied by an urban authority, it was held in the case of *Sheffield Waterworks Co.* v. *Sheffield Corporation* (1885) (55 L. J. M. C. 40; 54 L. T. 179), that where, subsequently to the making and demand of a general district rate, the valuation list upon which the rate was based was amended by the assessment committee by the reduction of the assessment of particular premises, sufficient cause was shown for non-payment of so much of the rate as corresponded to the reduction in rateable value made by the committee, although there had been no appeal against the general district rate.

The urban authority are empowered to reduce the sum at which any person has been assessed in the general district rate, if he has been over-rated, *i.e.*, if he has been assessed on a higher rateable value than that entered in the valuation list in respect of his property.

If a person assessed in any of the above rates considers that he is over-rated, and is unable, in any other way, to obtain the relief to which he considers himself entitled, he may appeal against the rate.

An appeal against a general district rate lies to the next court of quarter sessions held not less than 21 days after the demand of the rate. Fourteen days' notice of the appeal must be given to the urban authority, and the notice must state the ground of appeal.

In the case of separate rates levied by overseers to meet expenses of rural district councils, the same appeal lies to special or quarter sessions, as in the case of the poor rate.

Any separate borough rate, and any separate rate to meet contributions required by a county council, may also be appealed against in like manner as a poor rate.

Appeals against rates levied under the Lighting and Watching Act, 1833, may be made to quarter sessions, and are subject to the same provisions as appeals against poor rates.

III.—*Reduced Assessments in respect of Land not occupied by Buildings.*

1. Occupiers of land used as arable, meadow, or pasture ground only, or as woodlands, allotments, orchards, market gardens, or nursery grounds, are assessable to a general district rate in an urban district in respect of such land, in the proportion of one-fourth part only of the rateable value according to the valuation list; and in the case of a separate rate for special sanitary expenses in a rural district they are, according to circumstances, either to be assessed in respect of one-fourth part only of the rateable value of the land, or are to pay in respect of it one-fourth part only of the rate in the pound payable in respect of houses and other property.

Occupiers of houses, buildings, and property (other than land) are required to pay, in respect of their assessment to a lighting rate under the Lighting and Watching Act, a sum in the pound three times greater than that paid by occupiers of land. This has been held to mean that if the rate on houses &c. is 6*d.* in the pound, occupiers of land should pay only 2*d.* in the pound.

Failure, in rating such occupiers, to allow the partial exemption for which the Acts provide, would be a good ground of appeal against any of the three rates abovementioned.

2. In the case of rates which before the Agricultural Rates Act, 1896, came into operation were payable by an occupier of agricultural land in full, or in the proportion of more than half, such occupier is liable, so long as the Act continues in force, to pay one-half only of the rate in the pound payable on buildings and other hereditaments. This partial exemption does not, however, apply to rates assessed under any commission of sewers or in respect of any drainage, wall, embankment, or other work for the benefit of the land. The expression "agricultural land" means any land used as arable, meadow, or pasture ground only, cottage gardens exceeding one-quarter of an acre, market gardens, nursery grounds, orchards, or allotments, but does not include land occupied together with a house as a park, gardens other than as aforesaid, pleasure grounds, or any land kept or preserved mainly or exclusively for purposes of sport or recreation or land used as a racecourse. "Cottage" in this definition means a house occupied as a dwelling by a person of the labouring classes.

The rateable value of agricultural land is required to be stated separately from that of buildings or other hereditaments in the valuation list. The power of the assessment committee to amend the list on objection being made in the manner previously explained on page 2 is not affected by the carrying out of this requirement.

IV.—*Rating of Woods and Plantations.*

Poor Rate.—The Poor Relief Act of Elizabeth made an occupier of saleable underwoods liable to assessment to the poor rate. The underwood itself was rated, not the land upon which it grew. But by Section 14 of the Rating Act, 1874, so much of the Statute of Elizabeth as related to the taxation of an occupier of saleable underwoods was repealed, and by Section 3 of the Act, the Statute of Elizabeth, and the Acts amending the same, were extended to land used for a plantation or a wood or for the growth of saleable underwood, and not subject to any right of common.

Under this enactment it is the land, and not the timber, underwood, or other produce of the land, which is made the subject of assessment. It would seem that if land used as a plantation or a wood, or for the growth of saleable underwood, is subject to common rights, it is exempt from the poor rate and other local rates.

The method of estimating the gross estimated rental and rateable value of such woodlands is prescribed by Section 4 of the Act, and is as follows :—

(a) If the land is used only for a plantation or a wood, the value shall be estimated as if the land, instead of being a plantation or a wood, were let and occupied in its natural and unimproved state :

(b) If the land is used for the growth of saleable underwood, the value shall be estimated as if the land were let for that purpose :

(c) If the land is used both for a plantation or a wood and for the growth of saleable underwood, the value shall be estimated either as if the land were used only for a plantation or a wood, or as if the land were used only for the growth of the saleable underwood growing thereon, as the assessment committee may determine.

Land of the kind described in paragraph (a) should be assessed as if it were divested of timber or wood of any description, and its value determined without taking into account any improvement which has been made, or of which the land might be capable. In other words the land should be rated as if it were waste land. This view is supported by the case of the *Earl of Westmorland* v. *Southwark and Oundle* ((1877), 36 L.T. 108 ; 41 J.P. 231), in which it was decided that in ascertaining the rateable value of a plantation or wood as "land let and occupied in its natural and unimproved state" it was not admissible to base the estimate upon the rent which a hypothetical tenant would give after money had been laid out in grubbing up woods, in draining and fencing, and in making roads. In the case of *Eyton* v. *Mold Churchwardens and Overseers* ((1880), 6 Q.B.D. 13), it was held that the value of a right of sporting over land might properly be included in estimating the rateable value of a plantation or wood as land in its natural and unimproved state.

Woodlands are not agricultural land within the meaning of the Agricultural Rates Act, 1896, and an occupier of woodlands is liable to pay the full amount in the pound of any poor rate assessed upon him in respect of such property.

Other Local Rates.—By Section 10 of the Rating Act, 1874, any hereditament made rateable to the poor rate under that Act became subject to all other local rates leviable upon property rateable to the relief of the poor. Woodlands are thus rateable to the general district rate, and the separate rate for special sanitary expenses, and to any lighting rate levied in a rural parish under the Lighting and Watching Act, 1833. Information as to the abatements allowed to occupiers of woodlands in paying the general district rate or special sanitary rate has already been given in Section III. (1).

V.—*Rights of Sporting and Fishing.*

Under the old Statute (43 Elizabeth, c. 2) the sporting right was in no case separately rated, although, where the occupier of land retained the right of sporting or let it to another person, the value of the right formed an element in estimating the value of the land to the occupier (*Reg.* v. *Battle* (1866), L.R. 2 Q.B. 8).

Where the right is not severed from the occupation of the land (*i.e.*, where the owner retains both the land and the right, or lets them both to one tenant) the value of the sporting rights is still included in the valuation of the land ; but in any other case the right must be dealt with in the manner directed by Section 6 of the Rating Act, 1874.

Sub-section (1) of that section provides that where any right of sporting is severed from the occupation of the land, and is not let, and the owner of such right receives rent for the land, the right shall not be separately valued or rated, but the gross and rateable value of the land shall be estimated as if the right were not severed ; and if the rateable value is increased by reason of its being so estimated the occupier of the land may (unless he has specifically contracted to pay such rate in the event of an increase) deduct from his rent such portions of any poor or other local rate as is paid by him in respect of such increase.

The direction in Section 6 (1) is that the value of the land shall be estimated *as if the right were not severed.* It would appear, therefore, that in dealing with the right as an element of value, it ought not to be estimated upon any such consideration as that of the rent which a third person might be found to give for it ; but according to its worth, if any,

to the occupier of the land, upon the supposition that the right is not severed, or, in other words, that he himself is entitled to exercise the right without the power of making a profit by letting it.

The effect, therefore, of this provision is to place those lands which are let by an owner, with a reservation of the right of sporting, on the same footing in relation to rateability as the lands which he himself occupies, retaining the right to the game upon them.

The preceding remarks are mainly directed to those cases where the right of sporting is severed from the occupation of the land, but is retained by the owner. Where, however, the right is let to a person other than the occupier of the land, it is rateable as a separate hereditament, and either the owner or the lessee of the right may be rated, as the occupier of the right of sporting, under Section 6 (2) of the Act of 1874. The ordinary rules of law for determining the gross estimated rental and rateable value of other kinds of property will apply.

Subject to the provisions of Section 6, the owner of any right of sporting, when severed from the occupation of the land, may be rated as the occupier of the right, under Sub-section (3) of the section. But where the owner receives rent for the land he could not be rated under Sub-section (3) as the occupier of the right, because this case is dealt with by Sub-section (1) of the section.

For the purposes of the section the owner of the right is, (1) the person entitled to exercise the right if the right is not let, (2) if let, the person who is entitled to receive the rent for the same.

The poor rate, general district rate, special sanitary rate, and other local rates are payable in full upon sporting rights when severed from the occupation of the land over which they are exercised and separately assessed.

The observations relative to the right of sporting are equally applicable to the assessment of the right of fishing.

4, Whitehall Place, S.W.,
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BOARD OF AGRICULTURE AND FISHERIES.

Ensilage.

The system of ensilage was at first advocated mainly as a resource when wet weather prevented the saving of the hay crop in good condition, the contention being that it was preferable, under such circumstances, to convert grass and other fodder crops into silage, and this course was first widely adopted in the year 1888. It has been subsequently claimed, however, that the utility of the system is equally, if not more, marked in a year of drought, or when the root-crop fails, as by its means green fodder may be economised and stored in a succulent state for winter keep.

When ensilage was first introduced it was generally considered that the making of silage involved the construction of a silo, *i.e.*, a receptacle of some kind with sides of brick, stone or concrete. This was often too expensive for tenant farmers, and in some cases outhouses, parts of barns, and other buildings were converted for use as silos at comparatively small cost. A considerable stimulus, however, was given to the system by the discovery that good silage could be made in stacks and clamps by a comparatively cheap and simple process.

Materials suitable for Silage.

Meadow grass, lucerne, clover, sainfoin, Italian rye grass, grass and clover mixtures, maize, and any other green fodder crops that can be spared from the immediate requirements of the farm stock may be made into silage. In America by far the most important silage crop is maize, and of late years increased attention has been given to its cultivation in this country. It is sown from the middle of May to the middle of June, care being taken to obtain seed of high germinating power. The only serious trouble after sowing arises from the attack of rooks, and the workers engaged in sowing should not leave the field until some effective means of protection has been set up, "cottoning" or "stringing" being the common method of protecting the maize crop. For an account of the cultivation of maize for fodder Leaflet No. 73 may be consulted.

If the object in view is to provide for the deficiencies of a season of drought, the crop should be allowed to stand as late as the weather will permit, for although under ordinary circumstances it is acknowledged to be best to cut such crops as grass and clover for silage when in flower, something must be sacrificed with the view of getting the greatest possible bulk of material at such a time.

All classes of herbage upon farms may, if necessary, be utilised for silage, even weeds and nettles having been successfully employed. The margins of fields and the sides of hedges and other waste places may be brushed and the material so obtained ensiled. The leaves and young

shoots of most hardwood trees may also be utilised. If the material is too coarse for actual silage it will be useful for topping up the silos, stacks, or clamps. Coarse grass in meadows, pastures, and under trees in orchards and elsewhere, which stock frequently reject, may be made into eatable silage. Hop bines may be ensiled directly the hops have been picked, before the sap has disappeared.

Preparation of Materials.

Grass, clovers, lucerne, vetches, &c., require no preparation. They are simply mown as closely as possible and carted to the silo, stack, or clamp, where they are compressed as tightly as possible in order that the air may not penetrate between the layers. Where hop-bines are utilised, and a silo is available, it is well to cut them with the implement used to prepare them for manure, or they may be put into stacks or clamps whole, or cut into long lengths. Maize is usually roughly chaffed when put into silos, though it may also be employed uncut.

Special machines may be obtained for chaffing silage materials, and elevators for stacking them.

Silos.

Silos will naturally be used when available, and buildings that can be readily and economically converted may be made with some advantage into temporary silos. Cheap stave silos, now so common in America, may also be built. A silo of this description, 24 ft. deep and 16 ft. in diameter, would hold about 80 tons of silage, and would cost about £80. Silos, as compared with stacks and clamps, entail less waste, and are easier to manage.

To prepare "sweet" silage the silo should be filled somewhat slowly to ensure a temperature of from 130° to 160° F., which neutralises the acid fermentation. If by rapid filling and pressure air is excluded, the temperature does not rise so high, and "sour" silage is produced.

When the silos are filled the contents are pressed down by levers or machinery, or the necessary consolidation is secured by weighting with any kind of convenient material, such as earth, sand, bricks, or stones, piled upon planks and boards.

Silage Stacks.

Silage stacks are made in the same way as ordinary hay stacks. The materials are carted and stacked either in circular, square, or oblong stacks. It is important to have great and regular pressure, which may be adjusted, or which adjusts itself, as the mass shrinks. If this is obtainable, the materials may be put together as quickly as may be convenient. Several methods of pressing, as by chain pressure, hydraulic presses, and lever appliances, have been patented. Before pressing, the material should be carefully levelled.

Silage stacks may also be made without special machinery. In this case the material cannot be put together so quickly

and every part must be most carefully and firmly trodden, especially that near the outsides. Poles may be pitched at the corners and sides of the stack, and braced together at the top to guide the stack makers. A framework of four large planks may be made round the poles, and drawn up as the stack progresses by pulleys fastened to each end of the bracing at the top. This will keep the stack in shape, and allow the outsides to be well trodden down. The boards may be used to cover the stack when made, and then be heavily loaded with bricks, stones, or other weighty substances. The whole should be covered with straw or other material to keep out rain.

According to another method round stacks are made, these being built slowly and not pressed or weighted until complete. In such a case a layer of rough grasses or weeds should be put at the bottom, and similar material used to top up. The surface should be trodden down, and sand or earth laid on the top to a depth of about six inches. A trench should be dug round the stack if the surface drainage is not good, the earth from this trench serving to cover the silage. Sand and earth have been found the most useful materials to ensure even pressure. In building the stack it should be kept full in the middle, in order that it may finish convex. The use of a mixture consisting of a layer of one load of green oats, peas, beans, vetches, and Italian rye grass, alternating with a layer of meadow grass, has been recommended. Materials for making a silage-stack should, as a rule, be used whole, and be carted immediately after cutting.

Dry earth may be spread either directly on the silage or on intervening sheets of corrugated iron, felt, &c. In this case no other covering will be required.

The system of making silage in stacks involves a certain amount of waste not experienced in silos, a fair cut on the "outsides" being of little use. The method, however, is very valuable, especially in cases of emergency.

Silage Clamps.

Clamps are simple and inexpensive receptacles of the green crops enumerated above. They are advocated by practical men as most valuable, especially in the absence of a silo, when silage must be made immediately. Some stock-owners who have silos prefer to adopt the clamp method.

They may be made on slightly sloping ground by marking out the required size, the length exceeding the breadth, and carting material for silage within this area. The carts should be drawn on and over the heap precisely as when a manure mixen is made, and tipped where material is required to fill up. They must be drawn as closely to the sides as possible so as to give pressure there. When the middle has risen too high for further carting the sloping ends and sides should be cut off, the material being thrown on to the clamp, levelled,

and firmly trodden in. Dry earth should then be laid evenly upon the clamp, to a depth of 8-10 inches, either with or without an intervening layer of rough herbage, bracken or leaves.

On dry soils a trench may be dug 3 ft. deep, and of length and width according to the quantity of material. This may be packed tightly into the trench by the carts being led over it. A heavy roller drawn over the mass will help to consolidate it. The soil from the trench can be used for covering and weighting the clamp. The material cannot be too juicy, or even wet, to make good silage by this process.

Old chalk pits, so numerous in some districts, form serviceable receptacles for silage. The carts should be led over the mass of green material, which must be finally left in a somewhat conical form, and covered with earth to a depth of from 10 to 12 inches.

Where earth is used as a covering for silage stacks or clamps occasional inspection is necessary, as the earth sinks with the silage, and cracks are sometimes formed. These cracks should be filled up.

The use and value of Silage.

Many stock-owners make silage regularly, and use it as a valuable addition to ordinary food for stock. In one instance an owner of 45 dairy cows for some years kept his cows almost entirely upon silage made in stacks, with an allowance of oil cake. There is much other testimony as to its value for feeding milch cows as well as breeding ewes. For fatting beasts it has been claimed that well-made silage is as valuable as a combination of hay and turnips, and for lean stock of all kinds it may be used as a substitute for either hay or roots. Farm horses will do well on properly made silage.

It can be given alone, either cut or whole, or it may be chaffed with straw or hay. In seasons when hay and straw are scarce, and there is little of either to spare for cutting into chaff, silage may be given alone, when it proves of great value for supplying the bulky food that is absolutely essential for the health of ruminants.

NOTE.—The subject of ensilage received considerable attention at the hands of the Agricultural Department of the Privy Council in 1885, and as the result of an exhaustive local enquiry, a summary was published of Replies to Questions on Silos and Ensilage in Great Britain, in the form of a Parliamentary paper.* This was followed by a reproduction of the Reports of the private Ensilage Commission.†

4, Whitehall Place, London, S.W., August, 1893.
Revised, November, 1907.

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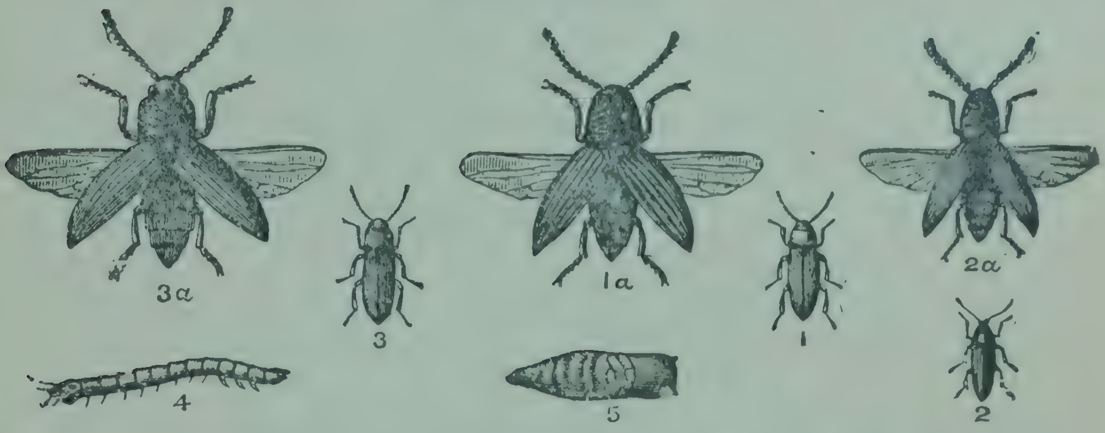
* C.—4536. † H. C. 308 of 1885 and H. C. 119 of 1886.

BOARD OF AGRICULTURE AND FISHERIES.

Wireworms.



1 and 1*a*. *Agriotes lineatus*.
2 and 2*a*. *Agriotes sputator*. (Natural size and magnified.)
3 and 3*a*. *Agriotes obscurus*.
4. Larva of *Agriotes lineatus*. (Natural size.)
5. Pupa.

Wireworms are the larvæ of beetles known popularly as Click Beetles or Skip Jacks; they belong to the large family of *Elateridæ*. One of the chief culprits among these beetles, is the Striped Click Beetle (*Agriotes lineatus*). The beetle is called "click" beetle, because when held by one end it bends its body and produces a clicking sound; while the name Skip Jack is derived from the fact that, when placed on its back, it throws itself into the air, also making a peculiar click in so doing.

Plants attacked.

Hardly any crop is free from wireworm ravages. Corn, roots, and vegetables of all kinds suffer in turn; hop and strawberry plants and tomatoes often receive serious injuries from these insects. When wireworms have got into the fibrous roots of these plants it is difficult to get at them, and they bite the shoots as fast as these make their appearance, eating the softer parts of the roots. In newly planted hop grounds, wireworms are often most destructive, destroying every shoot, checking growth, and sometimes killing the stock outright.

With their jaws wireworms quickly tear away the soft parts of the slightly bulbous stems of wheat, oat, and barley plants just above the roots, and kill the plants; they also bite the slender roots of young turnips, mangolds, carrots, cabbage, lettuce, &c.

Wireworms are more to be dreaded than most other insects, (1) because they are general feeders, not confining their attacks to the plants of a single natural order; (2) because they feed upon stems and roots at all times and seasons of the year, except during very hard frosts, when they go deeper into the earth; and (3) because as they live

for at least three years in the wireworm stage, their work of mischief is of long duration.

Description.

The Beetle.—The most common species of these beetles, *Agriotes lineatus* (Figs. 1 and 1*a*), is three-eighths of an inch long, and its wing expanse is slightly over half an inch. Its thorax is tawny ; the wing cases are brown, with lines of yellowish brown. The antennæ are reddish yellow, and the legs brown. Two other species are shown in the figure.

The Larva.—The larva (wireworm) of *Agriotes lineatus* (Fig. 4) is from six- to seven-eighths of an inch long, very shiny, and of yellow colour, becoming more chestnut coloured when dead. It has a few hairs on its body, one pair of four-jointed legs on each of the first three segments, and a swelling on the lower surface of the terminal segment. It has very strong jaws well adapted for biting roots.

Life History.

The beetles are found under stones, at the roots of grasses, upon grasses and various flowers and trees, in hedges and fields, and upon reeds. They fly well, and lay eggs near the roots of grasses, corn plants, and weeds, or in the earth. Taschenberg says that the beetles live all the winter in places of shelter and concealment, and that pairing takes place during the first warm days of spring. The wireworms which hatch from the eggs live in the earth, near the roots of the plants on which they feed.

After from three to five years, according to circumstances, the larva goes down deep into the earth, makes a little oval cocoon of particles of soil, and changes to a pupa (Fig. 5), from which the beetle emerges in two or three weeks.

Prevention and Remedies.

Numerous experiments both in the field and in the laboratory have been made to discover some means by which wireworms may be killed or prevented from attacking crops, and on the experience thus gained the following suggestions have been based.

(1.) Much good may be done in hop yards, gardens, and nurseries by trapping the click beetles. This may be done by laying about on the ground small heaps of lucerne, clover, or sainfoin, and covering them with tiles or pieces of board during May and June and as long as the beetles are noticeable. The beetles fly to these heaps and shelter beneath the green material, particularly if the ground is clean, and deposit their eggs there. These traps must be examined as often as possible, the beetles should be collected and the green stuff destroyed every ten days, and the ground beneath well beaten down so as to destroy any eggs that may be present. Boards or tiles might be placed beneath the bait so as to prevent any eggs from getting on the soil. As many as 100 click beetles have been taken from a single trap in a week.

(2.) Trapping the larvæ is also often successful. This is done by placing pieces of potatoes, or, best of all, beetroot under the earth in hop-hills, garden borders and so forth, marking the spots with pegs, and examining them every few days. Numbers of wireworms may be found buried in the baits and may then be collected and destroyed.

(3.) "Vaporite" a proprietary article which gives off a gas smelling of naphthalene has been used with some success in both field and garden. Employed in quantities of 1 cwt. per acre in the field it does some good in keeping wireworms away, while when freely used in gardens wireworms may be killed.

(4.) Ordinary superphosphate, or a mixed manure containing superphosphate, when drilled with the seed has been found to keep wireworms away. This method of prevention is recommended for spring sown corn crops.

(5.) For young crops, such as wheat, where wireworms are at work, heavy rolling with a ring roller does much good by consolidating the soil, and so preventing the wireworms from moving rapidly from plant to plant.

(6.) Stimulating manures should always be given when the crop is seen to be attacked by wireworms. Soot has been found to answer well, and under certain conditions even seems to have a definite effect upon the insects.

In districts where sea-weed is used as a manure, it is said wireworms do very little harm.

(7.) Neither gas-lime, lime, nor salt, so often recommended, has any definite effect upon the larvæ in the ground, but the first-named now and then seems to act as a deterrent and may be used with advantage on infested land prior to its being broken up. Gas-lime must be left for at least four weeks before it is worked into the land.

(8.) Clover lea and grass land are often full of the larvæ of these beetles, and the result is that when the land is broken up the first few crops are sometimes a complete failure, unless proper steps are taken to free the land from wireworms. Previous to being deeply ploughed the land should be fed off by sheep, which should be penned and fed so that not only all surface vegetation goes, but the land becomes well trodden down and saturated with urine, and such preventives as gas-lime, superphosphate or vaporite should be used.

(9.) Excellent results have followed the use of portable fowl-houses on infested land, which at the time of ploughing is turned over in sections. The fowls thus obtain access to the newly-ploughed land in small areas, which they can thoroughly search for grubs. The houses should be moved on every day.

(10.) In flower beds and borders where these pests do much harm to tender plants they can easily be destroyed by injecting bisulphide of carbon into the soil. This may be done as follows :—Pour a quarter of an ounce of bisulphide of carbon into a small hole made in the ground, and at

once cover over with a piece of tile with earth on the top. Care must be taken not to let the bisulphide touch the roots of any plants, and it must be remembered that this substance is both poisonous and highly inflammable. This operation is best done in the spring and early summer, the quantity of bisulphide of carbon indicated being enough for a square yard.

(11.) Heaps of leaf mould and manure should never be allowed to have weeds growing on them, and are best covered with a coating of gas-lime, which prevents not only click beetles, but also daddy longlegs from laying their eggs there. Gardens are frequently infested in this way, unless proper precautions are taken.

(12.) Rooks, starlings, jackdaws and plovers destroy large numbers of wireworms. The plover probably does the greatest amount of good in this respect, and the recent great increase in the wireworm is undoubtedly partly due to the decrease of the green plover, owing to the ruthless destruction of plovers' eggs.

(13.) Mustard and rape cake dust have been much employed as wireworm remedies. It is thought that these substances get rid of the pests ; on the contrary, they form a palatable food for Elater larvæ. They act by drawing the wireworms away from the plants, and in young crops good is no doubt for a time done by enabling the plants to grow away from the pest. The cake dust has no lasting effect and moreover probably encourages wireworms in the land. There is no doubt that the use of such manures as rape dust in hop gardens has tended to the great increase of these pests in such places.

(14.) Clean farming and suitable manuring are amongst the best preventives.

(15.) In the United States wireworms have proved very destructive to newly sown "corn." Fernald has found that seed receives complete protection if, before sowing, the seed is tarred and then "placed in a bucket containing fine dust and Paris green mixed in such proportions that the corn after being shaken up in the bucket, showed a greenish colour."

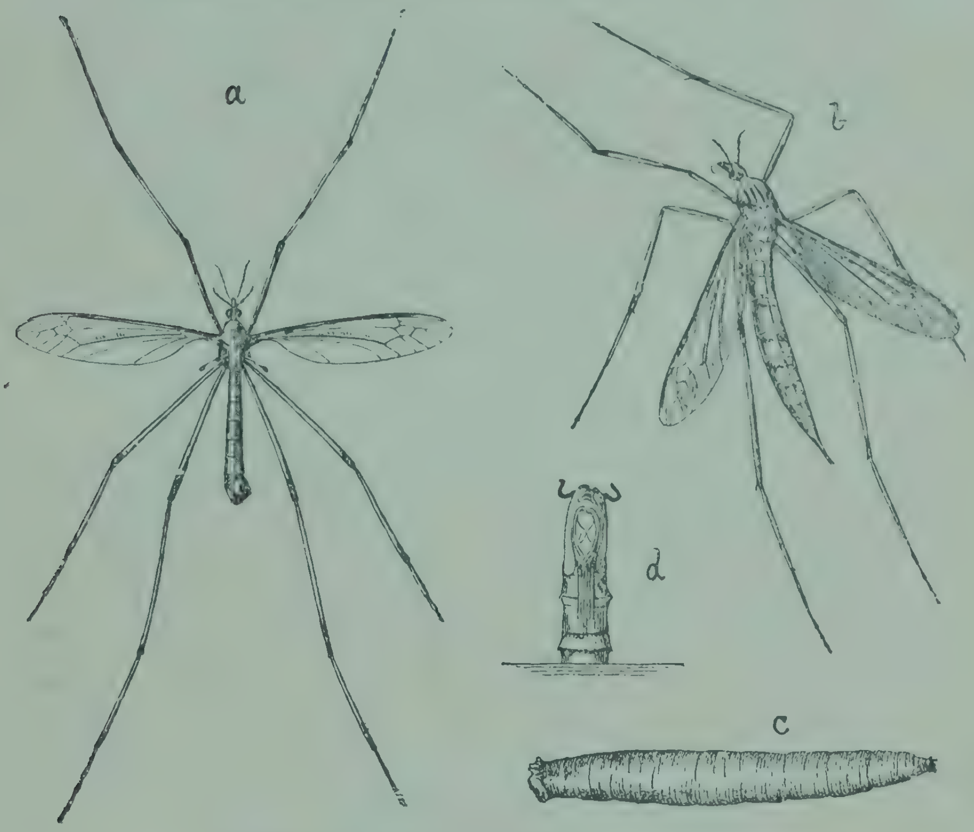
4, Whitehall Place, London, S.W.,
December, 1894.

Revised, March, 1912.

BOARD OF AGRICULTURE AND FISHERIES.

The Daddy Longlegs or Crane Fly.

(*Tipula oleracea, Tipula paludosa, &c.*)



Summer Crane Fly (*Tipula oleracea*).

a. Male. *b.* Female (after Ormerod). *c.* Larva. *d.* Pupa.

The larvæ, or grubs, of the huge, awkward, long-legged flies known familiarly as "Daddy Longlegs," are frequently very destructive to various crops of the farm and garden. These grubs are called "leather jackets" in some counties on account of the toughness of their skins. They attack indiscriminately all kinds of corn, grass, turnips, mangolds, clover, peas, beans, cabbages, and garden plants. Perhaps in the aggregate they do most damage to grass land, but the results of their attack are most conspicuous on cereals, and especially on oats after clover or ley. It is in spring or early summer that complaint is most often heard, and many cases of serious damage were recorded in 1904.

Description and Life History.

The term "Crane Fly" is applied indiscriminately to the two common species known to naturalists as *Tipula oleracea* and *Tipula paludosa*. The habits of both are

identical, but *Tipula oleracea* is the earlier insect of the two and occurs from May to August, while *Tipula paludosa* is met with from July (rarely June), to September, in which month, and also in August, the perfect insects may be found in great numbers issuing from the pupal cases in pastures, or engaged in laying their eggs. *Tipula oleracea* may be recognised by the presence of a pale longitudinal streak below and parallel to the front margin of the wing; in *Tipula paludosa* the wings are darker brown and without a pale streak in the female, and only a trace of it in the male. The body of the male, which is always smaller than the female, is in both species slightly swollen at the tip and ends abruptly, while in the female it terminates in a short pointed ovipositor. In colour *Tipula paludosa* is reddish brown, while *Tipula oleracea* is a greyer insect; in the female of the latter the wings are large and longer than the body, but in the female of *Tipula paludosa* they are much smaller and are conspicuously shorter than the body. The females of both species are rather less than an inch (11 lines), in length, with a wing expanse of two inches in *Tipula oleracea* as against an inch and a half in the case of the female of *Tipula paludosa*. The legs, as indicated by one of the popular names, are very long and slender, the hindmost pair being the longest.

There are several other species which are also injurious, including the Yellow Spotted Crane Fly (*Pachyrhina maculosa*).

The *larva* or grub is about an inch long. It is somewhat variable in colour, but generally brownish, or brown shaded with dark green or sometimes lighter and approaching ash-grey. Two light coloured lines may be traced down the back.

It puts out at pleasure its black head, furnished with strong jaws for biting; and on the hind surface of the last segment are the two openings which lead into the breathing tubes. At the tail end, which is cut square, there are several tubercles. Though it has no legs it moves about with comparative ease.

The *pupa* is nearly as long as the larva, and is brown in colour. In changing, spines are formed at each segment, as shown in the figure, by means of which the pupa wriggles up through the earth and the fly escapes, leaving the chrysalis case sticking half out of the ground. It is easily recognisable by the two curved horn-like processes in front.

It has been observed that while laying eggs the female moves over the ground with her body in a vertical position, by the help of the hind-legs—the two pairs of forelegs being in the air—and of the end of the abdomen, which performs the office of another pair. The eggs are placed by the ovipositor on the ground, or upon grass, weeds or rubbish. Egg-laying takes place in late summer and autumn.

According to Curtis one female will lay as many as 300 eggs. The eggs are elliptical in shape, and in colour are shining black: it is believed that they are hatched in about 15 days. The larvæ lie in the earth during the winter, feeding upon the stems of grasses and corn near the surface while the weather is open, and going deeper into the earth when frost comes. They have been found well grown and feeding voraciously on the roots and stems of corn and grasses in the month of January when the weather has been mild. There is room for accurate observations on the length of the life-cycle of the different species and the number of generations in a year.

Prevention and Remedies.

(1) Congenial habitats of the Daddy Longlegs flies are wet ditches, damp sides of hedgerows and headlands, marshes, and low-lying and undrained meadows. These are generally their headquarters and breeding places, and obvious methods of checking their increase are to keep ditches well brushed and cleaned out, to keep hedgerows well trimmed, and to drain wet land.

(2.) Grass and clover fields may be ploughed in July, care being taken to have the herbage well covered. This system is not uncommon in certain districts, where it is known as bastard fallowing.

If it is not practicable to break up the grass or clover leys so early, they may be dressed in July with three or four tons per acre of gas lime, which will destroy eggs or larvæ.

If neither of these suggestions is feasible, leys that are intended to be broken up in autumn should be kept as closely grazed as possible.

(3.) There is evidence that the larva of one species completes its feeding somewhat sooner than is generally believed. If this be so it would justify a later sowing of the oat crop when "grub" was feared. There are disadvantages attending such a late sowing, and some would prefer to take the risk of "grub" rather than run the danger of the crop failing, owing to weather conditions, from a late sowing. Late sowing has been practised with success on some farms in Aberdeenshire.

(4.) If no method of prevention has been attempted, or if the result is not satisfactory, something in the nature of a cure may be attempted in spring, provided the attack is not very virulent and is taken in time.

Towards the end of April, or early in May, when spring-sown oats are 2 to 3 inches long, they should be dressed with 1 to 2 cwt. per acre of nitrate of soda, or with 1 cwt. of this manure mixed with 2 to 3 cwt. of soot. After the dressing the land should get a double-harrowing, and a thorough

rolling with a heavy Cambridge roller. The harrowing brings a considerable number of the grubs to the surface, where they are preyed on by rooks, starlings, and other birds, whilst the roller kills a considerable proportion.

Top-dressing with kainit at the rate of 3 to 4 cwt. per acre has been tried with some success.

If towards the end of May it is considered that the crop is practically a failure it should be ploughed up, and about the end of June white turnips, rape, or mustard may be sown. By that time the "Leather Jackets" are getting into a quiescent condition, and are not likely to damage the new crop, and if the weather is favourable the crops indicated will keep down weeds and yield useful green food for autumn feeding.

(5.) When drilled crops, such as turnips, mangels, and potatoes, are attacked, the best plan is to hoe diligently by horse and hand. In this way many of the grubs are destroyed, or are exposed to the attack of birds.

(6.) Rooks, starlings, peewits, and other birds, devour the grubs in a wholesale manner. Starlings are especially useful when they congregate after the breeding season. It has been noticed that meadows and marshes near rookeries have escaped injury, while grass-lands at some distance from these sustained much barm.

4, Whitehall Place, S.W.,
July, 1894.

Revised, July, 1905.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 12.

BOARD OF AGRICULTURE AND FISHERIES.

The Gooseberry Saw-fly (*Nematus ribesii*, Curtis.).

FIG. 1.

Figures 1 and 2. Larva in the two last stages.
3. The Cocoon. 4. The Fly.

The Gooseberry Saw-fly is very troublesome in gooseberry plantations and gardens, and it also attacks red currant bushes, but not so frequently as gooseberry bushes. In many cases the leaves are quite cleared off, together with the young fruit, and unless the plague is checked it is sure to be renewed in succeeding seasons. When the pest has once become established in large plantations it can only be eradicated by wholesale methods. This insect is common in many European countries, and appeared in America and Canada about thirty-five years ago. It has now spread over the greater part of the American continent, according to Saunders, who believes that it was brought into America in the earth adhering to the roots of imported gooseberry and currant bushes.

Description.

The female saw-fly is rather more than a third of an inch in length and half an inch in spread of wings. The body is the colour of honey, the thorax having black spots and the

head being dark; the legs are yellowish, with the ends of the tibiæ and the joints of the feet black; the wings are iridescent.

The male is smaller than the female, its body is much narrower, and the thorax and abdomen are nearly all black.

The eggs (Fig. 5) are greenish-white.

The larva is a 20-legged caterpillar, there being in addition to the six thoracic legs, 14 abdominal pro-legs; it measures at first about the twelfth of an inch, but when full grown

FIG. 5.—Eggs of Gooseberry Sawfly on leaf, natural size. Some 60 eggs were found on this leaf.

nearly an inch (Figs. 1 and 2); the head is disproportionately large. The colour of the caterpillar varies at different stages. When newly-hatched it is almost white or greenish-white, with a black head and a few black spots on the body; after the first moult the colour is green, with very numerous black spots, the head is black, and the legs are ringed with black. In the last stage of its life as larva, the colour is light green, with no spots, except the first and last segments, which are orange, while the head is pale.

The cocoon (Fig. 3) is oval in shape and brown or yellow-brown in colour, the enclosed *pupa* being green or yellow-green.

Life History.

The adults appear in April or early in May, and the females lay their eggs, which are very numerous, on the under side of the leaves on or close to the veins. The eggs are inserted into slight incisions. The eggs found on a single leaf vary in number; nearly sixty were present on the leaf illustrated in Fig. 5, but smaller numbers are commoner. In about six days the eggs hatch and the young caterpillars feed in company on the leaf on which the eggs were laid, their presence being indicated by numerous small holes. They soon become distributed over other leaves and shoots. They feed for about four weeks and then the cocoons are spun, generally upon, or just beneath, the surface of the soil under the infested bushes; the cocoons of this first brood of caterpillars are occasionally found upon the stems and twigs of the bushes. In about 20 days the adults issue and proceed in turn to their egg-laying. There may be three generations in the year; the cocoons of the last brood of the year are found deeper in the ground than those of the earlier broods, and the caterpillars lie sheltering in them until the next spring, when pupation takes place.

Unfertilised females of this species sometimes lay eggs; the adults that result from such eggs are always males.

Treatment.

1.—The eggs are conspicuous, and the leaves bearing them should be collected and burnt; care should be taken that they are removed before the young caterpillars have crawled away and spread themselves over the plant.

2.—The caterpillars should be picked off the bushes by hand.

3.—The following materials are effective against the feeding caterpillars:—

a. *Hellebore* mixed with water in the proportion of one ounce to three gallons of water and two ounces of flour, and applied with a sprayer. Whilst being sprayed the mixture should be agitated so that the hellebore is kept in suspension. *Hellebore is poisonous*, and is dangerous if used within six weeks of the fruit being gathered.

b. *Arsenate of Lead*, bought in the paste form. If this insecticide is employed it must only be used very early so that the fruit may not have a coating.

c. *Paris Green* in the paste form, half an ounce to 10 gallons of water. This should not be used later than six weeks before the fruit is gathered.

d. *Strong lime water* has been found serviceable. This should be put on in a fine spray directed over every part of the bush for some time.

4.—The surface soil under the bushes should be removed for a depth of two inches, in winter, and be buried deeply in a hole dug for the purpose; it should be replaced with fresh earth and manure. This is an excellent measure.

5.—The ground under and close around infested bushes should be dressed with quick-lime, in the autumn, and dug deeply.

4, Whitehall Place, London, S.W.,
October, 1893.

Revised, August, 1910.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S W. Letters of application so addressed need not be stamped.

A pamphlet containing 22 Leaflets dealing with Insect and other Pests injurious to Fruit Trees and Bushes may be obtained from the same address, price 1d. post free.

BOARD OF AGRICULTURE AND FISHERIES.

Acorn Poisoning.

The Board of Agriculture and Fisheries consider it desirable to warn stockowners who are accustomed to turn cattle into parks, or on to commons, or other places where acorns are plentiful, that there is considerable risk of injurious effects arising from the consumption of large quantities of acorns, which, in cases of dearth of herbage, are certain to be eaten with avidity.

In the years 1868, 1870, 1884, and 1900, which were remarkable for a large yield of acorns after a long, dry, and hot summer, serious losses among young cattle occurred from outbreaks of what is known as the acorn disease, or acorn poisoning. In many districts, notably in Middlesex, Kent, Hertfordshire, Warwickshire, Lincolnshire, Northamptonshire, Wiltshire, Gloucestershire, Devonshire, the New Forest, Sussex, Surrey, Suffolk, Norfolk, and Derbyshire, extensive outbreaks of the disease occurred. Young cattle up to two years old suffered most severely. Milch cows and cattle over three years old were seldom affected. Sheep and pigs appeared to be unsusceptible to the poisonous action of the seeds, and only two or three cases of the disease were reported in these animals, while entire herds of young cattle were attacked and a large proportion of them succumbed.

Acorn poisoning is quite distinct from indigestion due to eating an excessive quantity of acorns. This accidental disorder may occur in ordinary seasons when animals are first allowed access to pasture where acorns abound. But the true acorn disease is distinguished by progressive wasting, entire loss of appetite, diarrhœa, discharge of an excessive quantity of pale urine, sore places inside the mouth, discharge from the nostrils, and also from the eyes, which are always sunken, giving to the animal a peculiar haggard expression. No fever is present from first to last, but, on the contrary, the temperature is commonly below the normal standard.

On post-mortem examination it is frequently noticed that all traces of the acorns have disappeared. The morbid changes are such as are seen when an irritant poison has been given.

Remedies of various kinds were tried in the great outbreaks of the disease, but no cure was discovered. Prevention is comparatively easy when the risk is released.

It is only necessary for absolute security to keep cattle from the pastures while acorns are falling. The danger will be materially lessened by collecting the acorns from the pastures, but this device does not prevent a considerable consumption of the nuts which fall during the night. If swine are allowed access to pastures on which acorns fall they will devour large numbers, on which they will thrive well, and, at the same time, proportionately reduce the quantity within the reach of cattle. It has also been suggested that when cattle are allowed access to acorns only during the daytime they should be supplied with a liberal allowance of food before they are turned out.

4, Whitehall Place, London, S.W.,
September, 1893.

Revised, November, 1902.

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BOARD OF AGRICULTURE AND FISHERIES.

The Raspberry Moth (*Lampronia rubiella*, Bjerk).

Moth and caterpillar, both magnified ; the lines show the natural size.

Both in England and Scotland the small red caterpillars of this moth, often called the Raspberry Stem-bud Caterpillar, are most destructive to raspberry canes. On many fruit farms the crop has been reduced by one-third or one-half in consequence of the attack of this insect, and much mischief is also often occasioned by it in gardens and allotments where patches of raspberry canes are cultivated. Upon close examination of the attacked raspberry canes it will be seen that the soft juicy part at the base of the buds has been eaten away, so as to injure the buds and prevent their foliage and sometimes the blossoms from being put forth. The larvæ also feed on the pith inside the terminal shoots; the attacked shoots flag and then die away in a very characteristic manner. A hole in the cane at the base of the buds may often be noticed in which the pupa will be found ensconced, and sometimes the pupa may be found in the tunnelled shoot.

In sending specimens of infested canes on May 3rd, 1907, a correspondent of the Board wrote : "I noticed the withered and curled appearance of a few of the shoots in my raspberry canes this afternoon, and concluded it was the effect of the recent cold weather, and went to pull them off, as being of no use. I found, however, that each of the shoots contained a small red grub, and even many of the shoots which at first sight appeared quite healthy proved on closer examination to be infected. Out of 400 canes hardly one has escaped."

Description.

The Raspberry Moth, *Lampronia rubiella*, belongs to the group *Tineina*. It is a most beautiful moth, of a light brown colour, with a series of yellow dots and

spots upon its forewings, the two most prominent being on the inner margin. The hinder wings are slightly lighter in colour, with light fringes. The head is yellowish-grey, and the antennae dull brown. It measures barely half an inch across its wings, and its body is only about the fourth of an inch in length.

The caterpillar is close upon a quarter of an inch long, decidedly pink in colour for the most part, though the shade varies somewhat in individuals, and becomes more red in most larvæ as they get older. The head is black, and there is a patch of black divided into two on the segment behind the head. It has three pairs of black or brown-black feet on the thoracic segments. The pro-legs number four pairs, and there is a pair at the hind end.

The pupa is about the fourth of an inch long, tapering somewhat unusually, and it has a spine upon the back on the last segment; it is reddish-yellow in colour, the wing covers being paler, and the abdomen somewhat pink.

Life History.

The moths may be seen at the end of May, but more commonly in June, flying round the raspberry canes. They fly by night as well as by day.

The moth places its eggs upon the flowers of the raspberry canes from the end of May to the middle of June. After five or six days the caterpillar may be found in the raised white receptacle upon which the fruit (or more correctly, the collection of little fruits composing the raspberry) is formed. The caterpillar does not appear to injure the fruit at this stage. In time the caterpillar makes its way out of the receptacle, either by crawling or by letting itself down by silken cords to the earth beneath the canes, and passes the winter in a flat white silken cocoon about $\frac{1}{12}$ of an inch in diameter. The cocoons are also found in crevices in the poles and under the rough rind of the stems The caterpillars leave their winter quarters on the first approach of spring*; according to Dr. Chapman they leave the cocoon early or late in March, according to the season. They crawl up the raspberry canes, and, getting to the buds, eat into these at their base, and, feeding upon them, make up for their long fast during the autumn and winter months.

When the time arrives for pupation, the caterpillar scoops out a hole in the pith of the cane, below the base of a bud, and here it turns to a chrysalis; the moth coming out in about 21 days.

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* In 1892 caterpillars of *Lampronia rubiella* were first found in raspberry buds on April 10th by Dr. Chapman. In 1899 Theobald found them at work in Kent a week earlier.

Methods of Prevention and Remedies.

1.—The caterpillars hibernate just under the surface of the ground, around and among the stocks of the raspberry canes, and in crevices in the poles, &c., and, as has been shown, they remain there from about midsummer until March. Therefore, deeply forking the ground round and between the stocks with a pronged fork, or even hoeing it with a three-toothed hoe, would destroy some and bury others so deeply that they could not get out.

2.—Cutting back the canes after an attack, and, as far as possible, doing away with stakes will have a good effect.

3.—Dr. Chapman has suggested the following practical method of prevention: "The caterpillars are in the crown of the stock, or near it, and under rubbish there collected. Rake this away, and earth the stock up again, and you will thus bury them, and most will perish."

4.—Soot, lime, ashes, or soot and lime mixed, which form a pungent compound, might be forked or hoed into the ground in the autumn or winter.

5.—When raspberry canes in field culture are nearly all cut away, so that there are but few canes or stems left, it would be easy to put a little thick soft soap composition containing paraffin oil, or some other offensive stuff, with a large paint brush, at the beginning of March, upon the lower part of each cane that is left, in order to prevent the caterpillars from crawling up. This would also damage such caterpillars as may hibernate there.

6.—Cutting off and burning the infested canes while the caterpillars are in the buds between April and the beginning of June, would destroy many caterpillars and pupæ. This may be very freely done, as raspberry canes throw up plenty of shoots to take the place of those cut away, and infested canes bear little or no fruit.

4, Whitehall Place, London, S.W.
October, 1893.

Revised, April, 1910.

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Leaflet No. 15.

BOARD OF AGRICULTURE AND FISHERIES.

The Apple Blossom Weevil (*Anthonomus pomorum*).

a, Weevil, nat. size ; *b*, magnified. *c*, Larva, nat. size ; *d*, magnified.
e, Pupa, nat. size ; *f*, magnified. *g*, Larva in blossom bud.

This insect very frequently causes much harm to the apple crops, and in the last few years its injuries have much increased in fruit-producing districts. Close examination of the blossoms shows that the little creamy-white larvæ of the weevil are in the centres of the flowers (Fig. *g*), destroying their powers of fructification. The action of this weevil upon the fruit blossoms of apple and sometimes pear trees is often mistaken for the effects of white frosts, when the petals have become brown or rust-coloured ; but if such blossoms are closely inspected, either the very pale yellow pupa of the weevil (Fig. *e*) will be found in them, or a little round hole in the side of the withered flower will be noticed, showing that the perfect weevil has eaten its way out of its cradle. Attacked blossoms readily fall when a tree is shaken, and very often naturally before the weevils escape. The beetle may remain some days in the dead blossom before it makes its exit.

Incredible damage is often caused by this weevil in apple and pear orchards in France. In some Departments, syndicates of defence against it have been formed, consisting of a committee in each Commune, to carry out a series of

operations calculated to destroy this dangerous enemy, as it is felt that it is only by united action among cultivators that such injurious insects can be stamped out.

Description.

The apple-blossom weevil is very small, only the fourth of an inch long, and the eighth of an inch in breadth (Figs. *a*, *b*). It is black, with down, or pubescence, of an ashy grey hue upon its body. Occasionally, specimens are found almost pitchy in colour. The thorax is black with coarse scanty white pubescence. The wing-cases have alternate bare and pubescent grey lines; behind the middle is a band composed of pale pubescence which is oblique, and forms, when the two wing-cases are closed, a characteristic pale V-shaped mark. There is a pale grey spot between the wing-cases in front. The legs are very dark reddish, almost black; the thighs of the first, or anterior, pair are large, and each is furnished with a formidable tooth. The middle and hind femora have a smaller tooth; the feet, or tarsi, are of a darker colour. The rostrum, or snout, is the most remarkable feature, being half as long as the body, slightly curved, and bearing the antennæ, which end in oval four-jointed clubs.

Like many other weevils, the apple blossom weevil falls down when disturbed, tucks in its legs and snout, and remains motionless, feigning death until the danger has passed

The egg is yellowish and oval.

The larva, or grub, is without feet, and is about the third of an inch long (Figs. *c*, *d*). It is wrinkled, and white at first, gradually becoming creamy-white. It has a brown head with two little brown spots on the first segment.

The pupa is nearly a quarter of an inch long, of a very pale yellow colour, with a long beak, or rostrum, and the legs folded on the under side of its body (Figs. *e*, *f*).

Life History.

In the first warm days of spring, the weevils issue from their winter retreats, and find their way to the apple trees. Some authorities consider that the females seldom use their wings, and that only the males fly freely. Others hold that both sexes fly equally well.

The female, either by flying or crawling, finds her way to the blossom-buds of apple and sometimes pear trees, and boring a hole with her snout, puts one egg within each blossom bud, and carefully closes up the hole. A female lays from 15 to 50 eggs, but puts one only in each flower-bud. The process of laying one egg takes about three-quarters of an hour.

Oviposition in an individual female may extend over a fortnight at least. The eggs hatch in from five to nine days. The larva, which lies in the bud in a curved form, attacks the stamens and carpels, and soon causes the petals to wither; the flower-bud changes to a rusty hue and decays (forming the so called "capped" buds). The larva in from 8 to 20 days turns into a pupa, the pupal state lasting from 7 to 10 days, when the weevil appears and escapes by a hole which it bores through the petals.

After this, the weevils live among the leaves of the fruit trees. It is not known whether they feed upon the leaves. A French authority, Dr. Henneguy, concludes from careful observation that they do not feed at all, but live upon a reserve of fat, stored up in their bodies during their previous state. They are not seen after the end of September, retiring for hibernation to chinks in the bark of apple and other trees, or concealing themselves beneath lichenous and mossy growths upon their branches, as well as under stones and rubbish beneath and around the trees, and in other similar refuges.

According to natural instinct, the weevils do not appear until the weather is mild and the flower-buds have begun to swell. If the season is, and continues, warm and growing, the effects of the attack are usually of a slight character. But should the weather be cold and changeable, as is so often the case in Great Britain and the north and western parts of France, the flower-buds are slowly developed, and the weevils lay their full complement of eggs, the hatching of which takes place before the flowers are fully open. They do not appear ever to lay their eggs in an open flower.

Varieties of apple trees which blossom very early and very late are more likely to escape the attacks of the weevil than those of the main crop whose blossom comes late in May in ordinary seasons.

Methods of Prevention, and Remedies.

1.—One mode of prevention is to spray the limbs and branches of apple trees, in February, with caustic alkali wash to destroy the lichens and mosses which serve as harbours for this weevil and other insects (*vide* Leaflet No. 70). This can be thrown up over the trees by means of a syringing machine with a powerful pump.

2.—All long grass, leaves, and rubbish should be cleared away underneath fruit trees on grass land.

3.—It is difficult to employ insecticides and insectifuges advantageously for this insect, but it might be useful to spray trees subject to its attack with kerosene emulsion made by dissolving ½ lb. of soft-soap in one gallon of boiling water, and pouring this while still boiling hot into

two gallons of paraffin, and churning violently until a butter-like mass results. For use dilute with thirty to forty parts of water. The emulsion should be sprayed over the trees in a fine mist. This might tend to prevent the weevils from egg-laying.

4.—A mode of decreasing the number of weevils consists in shaking the branches to make the insects fall on to cloths spread below. Cloths—old rick-cloths being best—may be cut and arranged so as to fit close round the trunks of the trees. Labourers can then shake the branches violently, with the aid of long poles with hooks at the ends. The cloths should be quickly swept with brooms, and the débris and the weevils shovelled into sacks. This must be done rapidly, before the weevils can get away. It is said that four men and two boys treated 110 trees in a day in this manner. If this is done, a still day should be chosen if possible.

From experiments made, it has been found necessary to perform this operation two or three times on each tree, as all the weevils cannot be shaken off at once. From a tree, for instance, from which at the first shaking 1,000 weevils had fallen, 385 were shaken off five hours later. In one orchard of 8 acres, having 347 trees, nearly 450,000 weevils were destroyed in three days, at a cost of 1*l*. A satisfactory crop of apples was obtained.

It should be pointed out that this operation must be carried out before the weevils have laid their eggs, and upon their first appearance, commencing with the earliest varieties of apple trees.

This mode of destroying the apple-blossom weevils might be advantageously practised in Great Britain. It need hardly be pointed out that the fruit growers in districts should combine to wage war in this fashion simultaneously, and with care and energy.

5.—Theobald recommends shaking down the attacked blossoms, which should be collected immediately, as should also any blossom that has fallen of itself, and burnt, for the destruction of the enclosed weevils.

4, Whitehall Place, London, S.W.,
October, 1893.

Revised, September, 1905.

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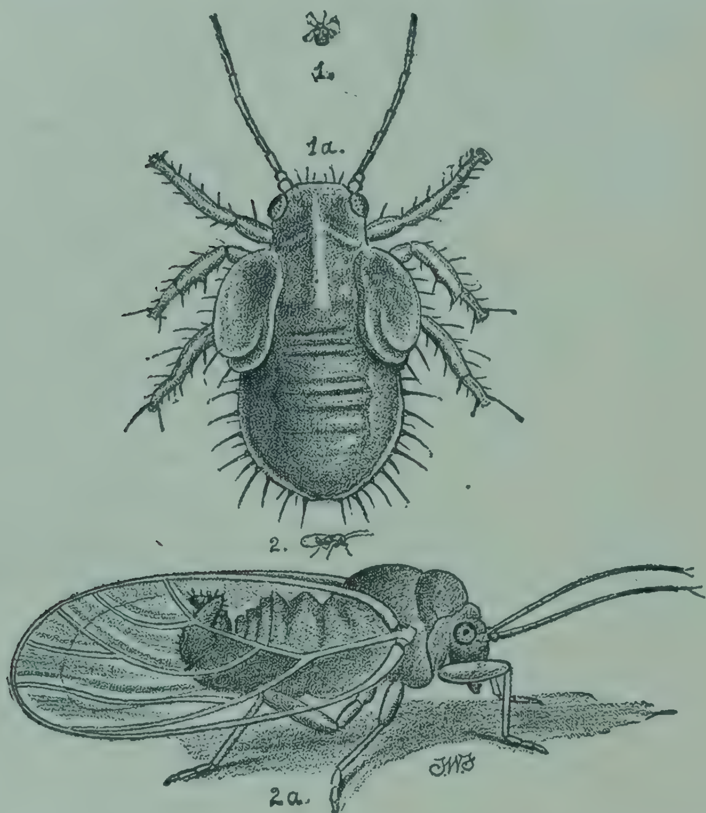
BOARD OF AGRICULTURE AND FISHERIES.

The Apple Sucker (*Psylla mali*, Förster).



1, larva, nat. size. 1*a*, larva after third moult, much magnified. 2, perfect insect, nat. size. 2*a*, much magnified.

This insect is frequently the unsuspected cause of much injury to the apple crop. Its larvæ, which cause the mischief, are so small and so closely concealed in the buds, that they may be easily passed over by casual observers. Their action upon the flower and leaf buds is often confounded with that of their relation, the aphides, which appear at about the same time. Later in the spring they suck away the juices from the stalks of both blossoms and blossom-buds. These *Psylla* larvæ may be seen by careful inspection within the folds of the buds. Attached parts punctured by the beak of the pest are drained of their sap; they fail to develop, wither and fall off.

Although the *Psylla mali* has been known in Great Britain for a long while, it is only somewhat recently that it has been recognised as a serious trouble to apple growers. It is well known in many European countries. In Germany it has done considerable harm and the well-known economic

entomologists, Schmidberger and Taschenberg, have written able treatises upon it. An allied species known as *Psylla pyricola* is very destructive in pear orchards in America, and has been elaborately described by Professor Slingerland, of the Cornell University Agricultural Experiment Station at Ithaca, in the State of New York.

Parts Attacked.

The leaf-buds, which may be destroyed.

The foliage leaves, which may be wrinkled, and become pale in colour and look frosted.

Flower-buds. Attack is worst on these, so that the collections of flower-buds do not expand and fruit fails.

From June onwards the adults may be seen on the leaves, but, in comparison with the earlier stages of the insect, they do little harm; but they are the egg-producers.

In addition to symptoms of attack mentioned above the presence of the pest can also be recognised by small opaque globules in and about the unopened flower-buds. After a while, too, the buds become filled with a dirty sticky fluid termed "honey-dew" which issues from the larvæ and mingles with their excretions.

Description of Insect.

Many persons have, there is no doubt, noticed quantities of little yellowish, or greenish-yellow, fly-like insects upon the leaves of apple trees in September and October, which upon being approached give a leap before using their wings to carry them to another leaf. These, in a certain degree, resemble some of the "frog-hoppers" and, in fact, they have been mistaken for them, but close examination will show them to be very different.

The winged *Psylla*, the perfect insect, appears from the middle of May to the middle of June and later. Its colour is green, with slight tinges or shades of yellow. The colour, however, is rather variable, differing according to the sex, and time of year. At some periods there are shades of yellow, green, red, or brownish-red, noticeable upon the body. These are more pronounced at pairing time, and the female is more brightly coloured than the male. The wings are transparent, or slightly testaceous; the legs and antennæ are yellow, the latter having two and sometimes four dark-coloured joints at the ends. The male is about one-twelfth of an inch, in length; the female is slightly larger.

The eggs are white or slightly yellow, and somewhat spindle-shaped; a thread-like appendage occurs at the pointed end. Taschenberg says that they become red, or yellowish-red, in the spring, just before the larvæ emerge from them.

The larvæ on hatching are very small, and have flat dirty yellow bodies, with brown or dark spots upon them. Their eyes are red and their feet brown. The changes in colour and form that accompany development will be noted under the life history.

Life History.

Pairing takes place in September, and the egg-laying may continue to November. In autumn of the abnormal year 1893 females were seen laying eggs as late as the 3rd of November. As a rule, the eggs are laid singly, and imbedded in the fine hairs upon the epidermis of the shoots. Occasionally there are two or three together in a row. The eggs are generally laid upon the youngest shoots. They are also placed upon older shoots and upon branches, but are then difficult to discover on account of the deep furrows and cracks, and mossy and lichenous growths.

The eggs remain until the weather becomes spring-like, when tiny flat larvæ emerge from them and at once get into the nearest buds. In the course of development of the larvæ several moults take place. The first moult soon occurs, after which the larva protrudes a small white globule, which remains attached by a white thread to its body. Should this be removed, another speedily forms. After a few days, when the second moult is accomplished, the larva becomes light green, and numerous white threads are produced forming a tangled mass, with which the larva covers itself. After about another week, with the third moult, the rudimentary wings are developed, as seen in Fig. 1*a*, and the eyes and tips of the antennæ become dark. This is the nymph stage. From the first appearance of the larva and until it is about a month old, there are continuous changes in its form. At the end of this time the nymph moults and the winged *Psylla* appears. The perfect *Psylla* appearing in May and June is said not to pair till September. Taschenberg inclines to the belief that there may be another generation during the summer, and it certainly is strange that the insect should pass so many weeks in apparent inactivity. Schmidberger, however, does not hint at a second generation, and no such brood has been observed in Great Britain.

Prevention and Remedies.

The times when measures may be taken with best results against the Apple Sucker are in the early spring and autumn.

1.—In the case of the early sorts of apples, infested trees should be sprayed with Paraffin Emulsion directly the apples

have been picked, to prevent the *Psylla* from laying eggs upon the shoots, and to kill the adults. The formula for Paraffin Emulsion is :—

Paraffin	...	...	2 gallons,
Water ...	...	...	1 gallon,
Soft Soap	...	...	$\frac{1}{2}$ lb.

Boil together the soft soap and water, and while still boiling hot pour into the paraffin ; churn thoroughly by means of a force pump till a creamy butter-like mass results. The thorough churning is important, as, if properly made, the stock keeps for a long time. For use, dilute with 10 gallons of water.

2.—Carbolic acid might be used at the rate of from 2 to 3 gallons to 100 gallons of water, and 6 lbs. of soft soap.

3.—For a winter spray the caustic alkali fluid described in Leaflet No. 70 is recommended, but proof is still wanting that this destroys the eggs.

4.—Spraying when the buds are open, and the larvæ are exposed, would be efficacious if carefully performed. The wash would run down into the bases of the open flower buds and of the expanded leaf-buds, and make the quarters of the insects unpleasant, or destroy some of them. The paraffin and the carbolic washes would kill the larvæ with which they come in contact. If the paraffin emulsion spray be used at this time the stock when made must be diluted with 30 times the amount of water. Spraying should be done as early as possible in the course of the attack, before much "honey-dew," which would hinder the action of the washes, has been exuded.

5.—Some small amount of prevention would ensue from pruning trees on which eggs had been laid. On young small trees, bushes, and pyramids, this might be adopted, and it would probably be advantageous to prune them, if infested, more closely than usual. But in the case of large orchard trees, it would be impossible to rely upon this mode of prevention. It is most important that all prunings should be burnt.

4, Whitehall Place, London, S.W.
December, 1893.

Revised, September, 1905.

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Leaflet No. 17.

BOARD OF AGRICULTURE AND FISHERIES.

Preservation of Commons.

The Board of Agriculture call attention to the recent Act of Parliament amending the law relating to Commons with a view to their better preservation and in connection with previous enactments.

By the Law of Commons Amendment Act, 1893, lately passed, it is enacted that an inclosure or approvement of any part of a Common purporting to be made under the Statute of Merton and the Statute of Westminster the second, or either of such statutes, shall not be valid unless it is made with the consent of the Board of Agriculture, who in giving or withholding their consent are to have regard to the same considerations, and are if necessary to hold the same inquiries, as are directed by the Commons Act, 1876, to be taken into consideration and held by the Board before forming an opinion whether an application under the Inclosure Acts shall be acceded to or not.

By the 6th section of the Copyhold Act, 1887, the lords of manors were forbidden to make grants of land not previously of copyhold tenure to any person to hold by copy of court roll or by any tenure of a customary nature without the previous consent of the Land Commissioners (now the Board of Agriculture), who in giving or withholding their consent were to have regard to the same considerations as are to be taken into account by them on giving or withholding their consent to any inclosure of common lands.

By the 31st section of the Commons Act, 1876, it is provided that any person intending to inclose or approve a Common, or part of a Common, otherwise than under the provisions of the Act, shall give notice to all persons claiming any legal right in such Common or part of a Common by publishing at least three months beforehand a statement of his intention to make such inclosure, for three successive times, and in two or more of the principal local newspapers in the county, town, or district in which the Common or part of a Common proposed to be inclosed is situate.

It follows from the above enactments that an inclosure of part of a Common, whether purporting to be made under the Statutes of Merton and Westminster the second, or

either of them, by way of approvement on the ground of sufficient pasture being left for the commoners, or under copyhold grant founded on a custom of the manor, cannot now be legally made without the consent of the Board of Agriculture, who in giving or withholding their consent are to have regard as well to the benefit of the neighbourhood as to private interests; and that any person intending to make such an inclosure should publish notice of his intention in the local newspapers.

4, Whitehall Place, London, S.W.,
December, 1893.

This leaflet is no longer issued separately.

BOARD OF AGRICULTURE AND FISHERIES.

FERTILISERS AND FEEDING STUFFS REGULATIONS.

The Fertilisers and Feeding Stuffs (General) Regulations, 1906. Dated December 27, 1906.*

The Board of Agriculture and Fisheries, in pursuance of the provisions of the Fertilisers and Feeding Stuffs Act, 1906, hereby make the following Regulations :—

Commencement.

1. These Regulations shall take effect on the 1st day of January, 1907, and remain in force until altered or revoked by the Board of Agriculture and Fisheries.

Definitions.

2. In these Regulations :—

"The Act" means the Fertilisers and Feeding Stuffs Act, 1906.

"Purchaser" and "seller" include their respective agents.

"Fertiliser" means any article used for fertilising the soil.

"Feeding stuff" means any article used as food for cattle (as defined by the Act, *i.e.*, bulls, cows, oxen, heifers, calves, sheep, goats, swine, or horses) or poultry.

Other expressions have the same respective meanings as in the Act.

Forms of Certificate of Agricultural Analyst (s. 3 (4) (*b*)).

3. The certificate of an Agricultural Analyst, in the case of a sample which has been divided into parts as in the Act provided, shall be in such one of the Forms A and B set forth in the schedule hereto as may be applicable to the case, with such variations as the circumstances require.

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* No. 944 of 1906.

Analyst's Report.

4. Every Agricultural Analyst shall, as soon as may be after the 31st day of March, the 30th day of June, the 30th day of September, and the 31st day of December in each year, report to the Board of Agriculture and Fisheries the results of all analyses made by him under section 3 (4) (*b*) of the Act during the three calendar months ending on such dates respectively; and he shall also forthwith report to the said Board the result of any such analysis in any case in which any provision of the Act appears to him to have been infringed.

Citric Acid Solvent (*s.* 10 (1)).

5. (*This Regulation has been revoked by the Fertilisers and Feeding Stuffs* (*General*) *Regulations*, 1908, *and is therefore omitted.* See *p.* 13.)

Revocation.

6. The Fertilisers and Feeding Stuffs Regulations, 1897, are hereby revoked as from the time at which these Regulations take effect.

Short Title.

7. These Regulations may be cited as the Fertilisers and Feeding Stuffs (General) Regulations, 1906.

In witness whereof the Board of Agriculture and Fisheries have hereunto set their official seal, this twenty-seventh day of December, one thousand nine hundred and six.

(L.S.) T. H. ELLIOTT,

Secretary.

THE SCHEDULE.

FORM A.

Certificate for Fertiliser.

I, the undersigned, Agricultural Analyst for the (1) , in pursuance of the provisions of the Fertilisers and Feeding Stuffs Act, 1906, hereby certify that I received on the day of 19 , from (2) two parts of a sample of (3) for analysis; which parts were duly sealed and fastened up and marked (4) , and were accompanied by the annexed (5) (copy of an) invoice, and also by the annexed (5) circular and advertisement,

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(1) Here insert the name of the county, borough, or district.
(2) Here insert the name of the person delivering the sample, and if so "by post."
(3) Here insert the name of the article as stated on the invoice.
(4) Here insert the distinguishing mark on the sample.
(5) The invoice or copy invoice, and any circular or advertisement given to the Analyst, will be initialed by the Analyst for purposes of identification and annexed to this certificate.

and that at the request of (6) , I have analysed one of the said parts and declare the result of my analysis to be as follows :—

I am of opinion that the said part contained the following percentages :—

(7) Nitrogen	...	...	per cent.
(8) Phosphates	Soluble	...	"
	Insoluble	...	"
(9) Potash	...	...	"
(10)			

As witness my hand this day of , 19 .

[*Name and Address of Analyst.*]

(6) Here insert name of the person requesting the analysis.

(7) The analyst may, in his discretion, add a statement of the amount of ammonia to which the amount of nitrogen stated in the certificate is equivalent.

(8) The phosphates in both cases to be given in terms of tribasic phosphate of lime, and in accordance with the definitions of "soluble" and "insoluble" contained in s. 10 (1) of the Act.

(9) The potash to be given in terms of potassium oxide, K_2O.

(10) Here state :—

(*a.*) The percentages of chemical and other ingredients present, when any statement of such percentages is contained in the invoice, or in any accompanying circular or advertisement descriptive of the article.

(*b.*) In what respect, if any, the invoice or the description of the article contained in any such circular or advertisement, is false in any material particular to the prejudice of the purchaser.

Form B.

Certificate for Feeding Stuff.

I, the undersigned, Agricultural Analyst for the (1) , in pursuance of the provisions of the Fertilisers and Feeding Stuffs Act, 1906, hereby certify that I received on the day of , 19 , from (2) two parts of a sample of (3) for analysis, which parts were duly sealed and fastened up and marked (4) , and were accompanied by the annexed (5) (copy of an) invoice, and also by the annexed (5) circular and advertisement and that at the request of (6) , I have analysed one of the said parts and declare the result of my analysis to be as follows :—

I am of opinion that the said part contained the following percentages :—

Oil	...	per cent.
Albuminoids	...	"
(7)		

and that (8)

As witness my hand this day of 19 .

[*Name and Address of Analyst.*]

(1) Here insert name of county, borough, or district.

(2) Here insert name of person delivering sample, and if so "by post."

(3) Here insert the name of article as stated on the invoice.

(4) Here insert the distinguishing mark on the sample.

(5) The invoice, or copy invoice, and any circular or advertisement given to the Analyst, will be initialed by the Analyst for purposes of identification and annexed to this certificate.

(6) Here insert name of the person requesting the analysis.

(7) The percentages of nutritive and other ingredients present, when any statement of such percentages is contained in the invoice, or in any accompanying circular or advertisement descriptive of the article.

(8) Here state, as the case may be :—

(*a.*) Whether the composition of the article agrees with the statements contained in the invoice, and with the name or description under which the article is sold, so far as the same implies that it is prepared from one particular substance or seed only, or from two or more particular substances or seeds only ; and, if not, in what respect.

(*b.*) In what respect, if any, the invoice or description of the article contained in any such circular or advertisement, is false in any material particular to the prejudice of the purchaser.

(*c.*) Whether the article is suitable for feeding purposes for cattle (as defined by the Act), or for poultry, as the case may be ; and, if not, in what respect.

(*d.*) Whether the article contains any ingredient deleterious to cattle (as defined by the Act) or to poultry, as the case may be, or any ingredient worthless for feeding purposes and not disclosed in the invoice ; and, if so, whether, in either case, to an extent materially prejudicial to the purchaser.

(*e.*) Where separate samples are taken of the portion of a feeding stuff which is mouldy, sour, or otherwise unsuitable for feeding purposes, and also of the residue of the feeding stuff, state the estimated proportion of the unsuitable feeding stuff in the certificate relating to the unsuitable portion.

The Fertilisers and Feeding Stuffs (Sampling, &c.) Regulations, 1906. Dated December 27, 1906.*

The Board of Agriculture and Fisheries, in pursuance of the provisions of the Fertilisers and Feeding Stuffs Act, 1906, hereby make the following Regulations :—

Commencement.

1. These Regulations shall take effect on the 1st day of January, 1907, and remain in force until altered or revoked by the Board of Agriculture and Fisheries.

Definitions.

2. In these Regulations :—

"The Act," means the Fertilisers and Feeding Stuffs Act, 1906.

"Purchaser" and "seller" include their respective agents.

"Fertiliser" means any article used for fertilising the soil.

"Feeding stuff" means any article used as food for cattle (as defined by the Act, *i.e.*, bulls, cows, oxen, heifers, calves, sheep, goats, swine, or horses) or poultry.

Other expressions have the same respective meanings as in the Act.

Appointment of Agent.

3. The purchaser of a fertiliser or feeding stuff may, for the purposes of the Act, appoint an agent, in the form set forth in the schedule hereto, or in a form to the like effect.

Invoice, &c., to be Sent to Analyst.

4. Where a sample is, or parts of a sample are, under section 3 of the Act, sent for analysis to the Chief Analyst or to an Agricultural Analyst, there shall be sent with the sample or parts the invoice (if any) relating to the article from which the sample was taken, or a copy of the invoice or of such part thereof as is hereinafter prescribed, and also any circular or advertisement, or a copy thereof, of the seller descriptive of such article which the purchaser may wish the analyst to consider in making his analysis and giving his certificate.

Prescribed Part of Invoice (s. 3 (7)).

5. Where a copy of an invoice is sent to the Chief Analyst or to an Agricultural Analyst in pursuance of the Act,

* No. 945 of 1906.

there may be omitted from such copy the name and address of, and any other matter which would identify or disclose, the seller of the article to which the invoice relates. The prescribed part of the invoice shall be the whole thereof except such name, address, and other matter as aforesaid.

Sampling.

6. Where, for the purposes of the Act, a sample is required to be taken in the prescribed manner, or in accordance with regulations made under the Act, the following provisions shall apply :—

(*a.*) The person taking the sample shall give to the seller at least three days' notice in writing of his intention to take the sample, with particulars as to the place, day, and hour of sampling. If the seller does not attend, the sample shall be taken in the presence of a witness.

(*b.*) The sample shall be taken in the following manner :—

In the case of a fertiliser—

(i.) When the fertiliser is delivered in bags or other packages, a number of bags or packages shall be selected as follows, viz. :—

Not less than 2 bags or packages where the quantity of the whole consignment does not exceed 1 ton.

Not less than 3 bags or packages where the quantity of the whole consignment exceeds 1 ton and does not exceed 2 tons.

Not less than 4 bags or packages where the quantity of the whole consignment exceeds 2 tons and does not exceed 3 tons ;

and, where the quantity exceeds 3 tons, one additional bag or package for every additional ton or part of a ton ; provided that in no case need more than 10 bags or packages be selected. The selection shall be made from different parts of the whole consignment.

(ii.) The selected bags or packages shall be emptied separately on a clean and dry floor, worked up with a spade, and one spadeful from each set aside. The spadefuls so set aside shall then be thoroughly mixed together and any lumps broken up by the hand or spade. From this mixture a sample, from about 2 lbs. to 4 lbs. in weight, shall be taken.

(iii.) When the fertiliser is delivered in bulk, a like number of portions, according to the quantity

of the whole consignment, shall be taken from different parts of the whole consignment and thoroughly mixed together on a clean and dry floor, and a sample, from about 2 lbs. to 4 lbs. in weight, shall be taken from the mixture.

(iv.) When the fertiliser consists of bulky material, uneven in character and likely to get matted together, such as shoddy, wool refuse, hair, &c., portions are to be taken from the selected bags or packages, or from different parts of the fertiliser if in bulk, the matted portions torn up, and all the portions thoroughly mixed together, The sample shall be taken from the mixture and shall be not less than 3 lbs. in weight.

(v.) As an alternative method, where neither the seller nor the buyer signifies objection thereto, the sample of a fertiliser delivered in bags or other packages may be taken by a sampling pale or spear or pipe or tube, which shall not be less than twenty-four inches in length, and two inches in diameter. The sampling instrument shall be pressed into the mouth of the bag or package so as to pass through the entire depth of the contents or to the extreme length of the sampling instrument. The several quantities thus taken from the selected bags or packages, which shall be at least double the number of bags or packages required to be selected under paragraph (i), shall be thoroughly mixed together and a sample, from about 2 lbs. to 4 lbs. in weight, shall be taken from the mixture.

In the case of a feeding stuff—

(vi.) When the feeding stuff is in the state of grain or meal, it shall be sampled in the same manner as prescribed for fertilisers. When the feeding stuff is in the state of cake, a number of cakes shall be selected, from different parts of the whole consignment, as follows :—

Not less than 5 cakes where the quantity of the consignment does not exceed 2 tons.

Not less than 10 cakes where the quantity exceeds 2 tons and does not exceed 5 tons.

Not less than 15 cakes where the quantity exceeds 5 tons and does not exceed 50 tons.

Not less than 25 cakes where the quantity exceeds 50 tons.

(vii.) The selected cakes shall either be passed through a cake-breaker or be broken into small pieces such as could be passed through a $1\frac{1}{2}$ inch

sieve. The broken cakes or the pieces shall be thoroughly mixed, and from the mixture a sample, not less than 6 lbs. in weight, shall be taken.

(viii.) As an alternative method, three strips shall be taken across the middle of each selected cake; and each of the three parts, into which (under Regulation 7) a sample is to be divided, shall contain one strip of each selected cake.

(ix.) Where, on delivery of the consignment, any appreciable portion of the feeding stuff is found to be mouldy, sour, or otherwise unsuitable for feeding purposes, separate samples are to be taken of the unsuitable portion and of the residue of the feeding stuff respectively; and, in the case of unsuitable cakes, the sample may consist of several large pieces fairly representative thereof. An estimate shall be made by the person taking the sample as to the proportion of the feeding stuff unsuitable for feeding purposes and shall be communicated in writing by him to the Analyst.

(x.) When the feeding stuff is in a fluid or semi-fluid condition, three packages shall be selected, and, after the contents have been well stirred or shaken, a portion shall immediately be taken from each. The several portions shall then be thoroughly mixed together in a clean vessel, and from the mixture a sample, from about 2 lbs. to 4 lbs. in weight, shall be taken.

In the case of both fertilisers and feeding stuffs:—

(xi.) Where the quantity of the whole consignment does not exceed 2 cwts., the sample may consist of such a portion of the consignment as is fairly representative of the whole, and the sample shall be of such a quantity that each of the parts, into which (under Regulation 7) it is to be divided, will be sufficient to enable a proper analysis to be made thereof.

(*c.*) General directions as to sampling:—

(xii.) In every case the sampling shall be done as quickly as is possible consistently with due care, and the material shall not be allowed to be exposed any longer than is absolutely necessary.

(xiii.) Each of the parts, into which (under Regulation 7) the sample is to be divided, shall be packed in a dry, clean bottle, or jar, or (except in the case of a fertiliser) in a dry clean tin, or

in some other suitable manner, so that the original composition of the fertiliser or feeding stuff may be preserved.

(xiv.) Each of the said parts of the sample shall be so packed and secured that it cannot be tampered with, and shall be sealed and initialed by the person taking the sample. It may also be sealed by the purchaser and the seller, if present, and sc desiring. If the seller does not attend, the witness shall initial it. It shall be marked with the name of the article, the date and the place of the sampling, and with some distinguishing number, in such a manner that the particulars so marked can be seen without breaking the seal or seals.

(xv.) Where a sample is taken in the presence of, and sealed by, the seller as well as the purchaser, it shall be deemed, as between the purchaser and the seller, to have been taken in accordance with these Regulations.

Division of Sample, &c.

7. Where a sample has been taken, under s. 3 of the Act, with a view to the institution of any civil or criminal proceeding, the person taking the sample shall divide it into three parts, as nearly as possible equal, and shall cause each part to be marked, sealed, and fastened up, and shall forthwith deliver or send by post two parts to the Agricultural Analyst and one part to the seller.

Short Title.

8. These Regulations may be cited as the Fertilisers and Feeding Stuffs (Sampling, &c.) Regulations, 1906.

In witness whereof the Board of Agriculture and Fisheries have hereunto set their Official Seal this twenty-seventh day of December, one thousand nine hundred and six.

(L.S.) T. H. ELLIOTT,

Secretary.

THE SCHEDULE.

FORM.

Appointment by Purchaser of Agent for the purposes of the Fertilisers and Feeding Stuffs Act, 1906.

I, *A.B.*, of hereby appoint *C.D.*, of *or* the Secretary for the time being of the Association [*or as the case may be*] to do on my behalf all things necessary for the purpose of obtaining an analysis under the Fertilisers and Feeding Stuffs Act, 1906, of the fertiliser *or* feeding stuff bought by me under an invoice, a copy of which is annexed.

The Fertilisers and Feeding Stuffs (Limits of Error) Regulations, 1910. Dated January 25, 1910.*

The Board of Agriculture and Fisheries, in pursuance of the provisions of the Fertilisers and Feeding Stuffs Act, 1906, hereby make the following Regulations :—

Commencement.

1. These Regulations shall take effect on the 1st day of March, 1910, and remain in force until altered or revoked by the Board of Agriculture and Fisheries.

Definitions.

2. In these Regulations—

"The Act" means the Fertilisers and Feeding Stuffs Act, 1906.

"Purchaser" and "seller" include their respective agents.

"Fertiliser" means any article sold for use as a fertiliser of the soil, which has been subjected to any artificial process in the United Kingdom or imported from abroad.

"Feeding stuff" means any article sold for use as food for cattle (as defined by the Act, *i.e.*, bulls, cows, oxen, heifers, calves, sheep, goats, swine, or horses) or poultry, which has been artificially prepared otherwise than by being mixed, broken, ground, or chopped.

Other expressions have the same respective meanings as in the Act.

* No. 90 of 1910.

Limits of Error.

3. For the purposes of the provisions of Section 1 of the Act, concerning the effect, as a warranty, of the statements made in the invoice of a fertiliser or of a feeding stuff (as above defined in Regulation 2) respecting the percentages of nitrogen, phosphates, and potash contained in the fertiliser, or of oil and albuminoids contained in the feeding stuff, the limits of error shall be as set forth in the Schedules hereto.

Short Title.

4. These Regulations may be cited as the Fertilisers and Feeding Stuffs (Limits of Error) Regulations, 1910, and the Fertilisers and Feeding Stuffs (Limits of Error) Regulations, 1906, are hereby revoked as from the time at which these Regulations take effect.

In witness whereof the Board of Agriculture and Fisheries have hereunto set their official seal, this twenty-fifth day of January, nineteen hundred and ten.

(L.S.) T. H. ELLIOTT,
Secretary.

FIRST SCHEDULE.

FERTILISERS.

Note.—In this Schedule the figures relating to Limits of Error represent percentages of the whole bulk.

Example of Application of Schedule.—In the case of a Bone Compound, if the percentages stated in the invoice are, soluble phosphates, 20; insoluble phosphates, 8; nitrogen, 1; then the warranty implied under s. 1 (1) of the Act will be that the fertiliser contains:—soluble phosphates, 19 to 21 per cent.; insoluble phosphates, 7 to 9 per cent.; nitrogen, ·7 to 1·3 per cent.

Description of Fertiliser.	Limits of Error.			
	Soluble Phosphates.	Insoluble Phosphates.	Nitrogen.	Potash.
1. Superphosphate	1	—	—	—
2. Dissolved Bones (Vitriolized or Vitriolated) made from Bones (whether raw or steamed or boiled) and Acid only:—				
(I) When the total of the percentages of Phosphates (soluble and insoluble) stated in the invoice amounts to 32 or more, then—				
(*a*) If the excess of the actual percentage of insoluble Phosphates over that stated in the invoice is 3 or more	4	—	·3	—

Description of Fertiliser.	Limits of Error. Soluble Phosphates.	Insoluble Phosphates.	Nitrogen.	Potash.
(*b*) If such excess is not less than 2, but is less than 3	3	—	·3	—
(*c*) If such excess is not less than 1, but is less than 2	2	—	·3	—
(II.) In all other cases	1	1	·3	—
3. Bone Compounds	1	1	·3	—
4. Compound Manures (other than Bone Compounds, but including Dissolved or Equalised Guano):—				
(*a*) If the respective percentages of Nitrogen and Potash stated in the invoice do not exceed 4	1	1	·3	·3
(*b*) If such respective percentages exceed 4 ...	1	1	·5	·5
5. Sulphate of Ammonia	—	—	·5	—
6. Nitrate of Soda	—	—	·5	—
7. Ground Hoofs and Horns	—	—	·5	—
8. Dried Blood	—	—	·5	—
9. Fish Guano and Meat Meal	—	2	·5	—
10. All Cakes and Meals (other than Bone or Meat Meal)	—	—	·5	—
11. Ground Bones and Bone Meal	—	2	·5	—
12. Basic Slag and Basic Superphosphate	2*	2	—	—
13. Shoddy, Wool, and Hair Waste	—	—	1	—
14. Kainit and other Potash Salts :—				
(*a*) Where the percentage of Potash stated in the invoice does not exceed 15	—	—	—	1
(*b*) Where such percentage exceeds 15	—	—	—	2
15. Nitrate of Potash	—	—	·5	2
16. Peruvian and other natural Imported Guanos :—				
(*a*) Where the percentage of insoluble phosphate stated in the invoice does not exceed 30	—	3	—	·5
(*b*) Where such percentage of insoluble phosphate exceeds 30	—	5	—	·5
(*c*) Where the percentage of Nitrogen stated in the invoice does not exceed 3.	—	—	·5	·5
(*d*) Where such percentage of Nitrogen exceeds 3 and does not exceed 5	—	—	·75	·5
(*e*) Where such percentage of Nitrogen exceeds 5	—	—	1	·5

* That is, soluble in a solution of Citric Acid of the prescribed strength.

SECOND SCHEDULE.

FEEDING STUFFS.

Note.—In this Schedule the percentage of albuminoids is to be taken as the percentage of nitrogen (other than nitrogen present as ammoniacal or nitric nitrogen) multiplied by 6·25.

Example of Application of Schedule.—In the case of a linseed cake, if the percentages stated in the invoice are, oil, 10 ; albuminoids, 30 ; then the warranty implied under s. 1 (2) of the Act will be that the linseed cake contains :—oil, 8·75 to 11·25 per cent.; albuminoids, 26·25 to 33·75 per cent.

Description of Feeding Stuff.	Limits of Error.
Decorticated Cotton Cake Undecorticated Cotton Cake Earth Nut or Ground Nut Cake Palm Kernel or Palm Nut Cake Cocoanut Cake Niger Seed Cake Sesame Seed Cake Sunflower Seed Cake Hemp Seed Cake Kurdee or Safflower Cake Compound Cakes Compound Meals	One-tenth of the percentage of oil and one-tenth of the percentage of albuminoids stated in the invoice.
Linseed Cake Rape Cake Soya Bean Cake Maize Products	One-eighth of the percentage of oil and one-eighth of the percentage of albuminoids stated in the invoice.
All other feeding stuffs (as above defined in Regulation 2) not otherwise specified in this Schedule	One-fifth of the percentage of oil and one-fifth of the percentage of albuminoids stated in the invoice.

Note.—The term "Cake" includes ground cake and meal from which oil has been removed by any process.

The Fertilisers and Feeding Stuffs (General) Regulations, 1907. Dated September 18, 1907.*

The Board of Agriculture and Fisheries, in pursuance of the provisions of the Fertilisers and Feeding Stuffs Act, 1906, hereby make the following Regulations :—

Regulation as to the Analyst to whom Samples are to be sent.

1. Where under the Fertilisers and Feeding Stuffs Act, 1906, any person desires that a sample shall be analysed by the agricultural analyst, the sample or parts of the sample, as the case may be, shall be sent to such agricultural analyst as is hereby prescribed, that is to say :—

(1) if the sample is taken in a county, or in a county borough or a burgh of which the council have appointed or concurred in appointing an agricultural analyst, then to the analyst appointed for the county or borough or burgh ;

* No. 752 of 1907.

(2) if the sample is taken in a county borough of which the council have not appointed or concurred in appointing an agricultural analyst, then to the analyst appointed for the county in which for the purposes of the Local Government Act, 1888, the borough is deemed to be situate ; and

(3) if the sample is taken in a burgh of which the council have not appointed or concurred in appointing an agricultural analyst, then to the analyst appointed for the county within which the burgh is situated or with which it has the longest common boundary.

Commencement.

2. These Regulations shall take effect on the 1st day of January, 1908, and remain in force until altered or revoked by the Board of Agriculture and Fisheries.

Short Title.

3. These Regulations may be cited as the Fertilisers and Feeding Stuffs (General) Regulations, 1907.

In witness whereof the Board of Agriculture and Fisheries have hereunto set their official seal, this eighteenth day of September, one thousand nine hundred and seven.

(L.S.) T. H. ELLIOTT,
Secretary.

The Fertilisers and Feeding Stuffs (General) Regulations, 1908. Dated November 9, 1908.*

The Board of Agriculture and Fisheries, in pursuance of the provisions of the Fertilisers and Feeding Stuffs Act, 1906, hereby make the following Regulations :—

Commencement.

1. These Regulations shall take effect on the first day of January, 1909, and remain in force until altered or revoked by the Board of Agriculture and Fisheries.

Definition.

2. In these Regulations, "fertiliser" means any article used for fertilising the soil.

Citric Acid Solvent (s. 10 (1)).

3. When in an invoice relating to a fertiliser a certain percentage of the fertiliser is stated to be phosphate soluble in citric acid, this shall be taken to mean that it is capable

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* No. 963 of 1908.

of being dissolved to the extent of such percentage when 5 grams of the fertiliser and 500 cubic centimetres of water containing 10 grams of pure crystallised citric acid, or alternatively when 5 grams of the fertiliser, moistened with 5 cubic centimetres of alcohol or methylated spirit, and 495 cubic centimetres of water containing 10 grams of pure crystallised citric acid, are continuously agitated during 30 minutes in a stoppered flask or bottle of about 1 litre capacity fitted into a mechanical shaking apparatus.

Revocation.

4. Regulation No. 5 of the Fertilisers and Feeding Stuffs (General) Regulations, 1906, is hereby revoked.

Short Title.

5. These Regulations may be cited as the Fertilisers and Feeding Stuffs (General) Regulations, 1908.

In witness whereof the Board of Agriculture and Fisheries have hereunto set their official seal, this ninth day of November, nineteen hundred and eight.

(L.S.) T. H. MIDDLETON,
Assistant Secretary.

The Fertilisers and Feeding Stuffs (Methods of Analysis) Regulations, 1908. Dated November 9, 1908.*

The Board of Agriculture and Fisheries, in pursuance of the provisions of the Fertilisers and Feeding Stuffs Act, 1906, hereby make the following Regulations :—

Commencement.

1. These Regulations shall take effect on the first day of January, 1909, and remain in force until altered or revoked by the Board of Agriculture and Fisheries.

Definitions.

2. In these Regulations—

"The Act" means the Fertilisers and Feeding Stuffs Act, 1906.

"Fertiliser" means any article used for fertilising the soil.

"Feeding stuff" means any article used as food for cattle (as defined by the Act, *i.e.*, bulls, cows, oxen, heifers, calves, sheep, goats, swine, or horses) or poultry.

Other expressions have the same respective meanings as in the Act.

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* No. 964 of 1908.

Methods of Analysis of Fertilisers.

3. The methods of analysis of a fertiliser for the purposes of the Act shall be as follows :—

(*i.*) *Preparation of the sample for analysis.*

(*a*) In the case of powdered fertilisers in a dry, or moderately dry, condition, the sample shall be passed through a sieve with perforations about one millimetre in diameter.

Adventitious materials which cannot be conveniently crushed, *e.g.*, fragments of metal in basic slag, shall be removed and allowed for.

(*b*) Other substances which are dry enough to powder but which are not in a fine condition shall be pulverised until the sample passes through a sieve with perforations about one millimetre in diameter.

(*c*) Wool, hair, hoof, shoddy, and similar substances, shall be pulled apart and cut until in a fine condition ; or, if dry, they may be passed through a shredding machine.

(*d*) Moist fertilisers which do not admit of being passed through a sieve shall be thoroughly mixed by the most suitable means.

(*e*) In the case of horn, shoddy, and other substances which gain or lose water during the process of pulverising, the proportion of water shall be estimated in the coarse and in the powdered condition respectively, and the results of the analysis of the powdered sample shall be calculated to the water content of the original coarse substance.

(*f*) Crystalline or saline materials, such as sulphate of ammonia, nitrate of soda, or potash salts, may be prepared by being well mixed and rapidly ground in a stoneware mortar, the portion finally reserved for analysis being especially finely ground.

(*g*) When the sample has been passed through the sieve and thoroughly mixed, or, if not passed through the sieve, has been thoroughly mixed, a part of it not being less than 100 grams shall be placed in a stoppered bottle, and from this the portions for analysis shall be weighed.

(*ii.*) *Determination of moisture* (*loss on drying*).

A weighed quantity of the sample shall be dried at 100° C.

(*iii.*) *Determination of nitrogen.*

The presence or absence of nitrates must first be ascertained.

(*a*) *Nitrogen in absence of nitrates.*

(α) A weighed portion of the sample shall be transferred to a Kjeldahl digestion flask; 10 grams of potassium sulphate and 25 cubic centimetres of concentrated sulphuric acid shall be added, and the flask shall be heated until a clear liquid, colourless, or of light straw colour, is obtained. The operation may be accelerated by the addition of a small crystal of copper sulphate or a globule of mercury to the liquid in the digestion flask.

(β) The quantity of ammonia shall be determined by distillation into standard acid after liberation with alkali, and, where mercury has been used, with the addition also of sodium or potassium sulphide solution.

(*b*) *Nitrogen when nitrates are present.*

(α) A weighed portion of the sample shall be transferred to a Kjeldahl digestion flask; 30 cubic centimetres of concentrated sulphuric acid, containing 1 gram of salicylic acid, shall be added, and the flask shall be shaken so as to mix its contents without delay. The shaking shall be continued at intervals during ten minutes, the flask being kept cool, and then 5 grams of sodium thiosulphate and 10 grams of potassium sulphate shall be added. The flask shall be heated until the contents are colourless or nearly so. Copper sulphate or mercury may be used as above described in paragraph (*iii.*) (*a*) (α).

(β) The quantity of ammonia shall be determined as above prescribed in paragraph (*iii.*) (*a*) (β).

(*c*) *Nitrogen in form of ammonium salts.*

A weighed portion of the sample shall be transferred to a distillation flask, and the quantity of ammonia shall be determined as above prescribed in paragraph (*iii.*) (*a*) (β).

(*d*) *Nitrogen in nitrates in the absence of ammonium salts and of organic nitrogen.*

One gram of the sample shall be placed in a half-litre Erlenmeyer flask with 50 cubic centimetres of water. 10 grams of reduced iron and 20 cubic centimetres of sulphuric acid of 1·35 specific gravity shall be added. The flask shall be closed with a rubber stopper provided with a thistle tube, the head of which shall be half filled with glass beads. The liquid shall be boiled for five minutes, and the flask shall then be removed from the flame, any liquid that may have accumulated among the beads being rinsed back with water into the flask. The solution shall be boiled for three minutes more,

and the beads again washed with a little water. The quantity of ammonia shall then be determined as above prescribed in paragraph (*iii.*) (*a*) (β).

In cases in which the proportion of nitrates is small a larger quantity of the sample shall be taken.

(*e*) *Control experiment in determination of nitrogen.*

The materials used in any of the methods described under this paragraph (*iii.*) shall be examined as to their freedom from nitrogen by means of a control experiment carried out under similar conditions with the same quantities of the reagents which have been employed in the actual analysis, in the case of (*a*) one gram of pure sugar being used in place of the weighed portion of the sample. The quantity of standard acid used in the control experiment shall be deducted from the total quantity of acid found to have been neutralised in the distillation of the sample.

(*iv.*) *Determination of phosphates.*

(*a*) *Phosphates soluble in water.*

In the case of superphosphates, dissolved bones and similar substances, 20 grams of the sample shall be continuously agitated for 30 minutes in a litre flask with 800 cubic centimetres of water. The flask shall then be filled to the mark, and again shaken, and the contents shall be filtered. 50 cubic centimetres of the filtrate shall be boiled with 20 cubic centimetres of concentrated nitric acid, and the phosphoric acid shall be determined by the molybdate method prescribed below in paragraph (*iv.*) (*d*).

In the case of fertilisers in which the proportion of phosphates soluble in water is small, a larger quantity of the filtrate prepared as above shall be taken.

(*b*) *Phosphates soluble in the prescribed citric acid solution.*

5 grams of the sample shall be transferred to a stoppered bottle of about 1 litre capacity. 10 grams of pure crystallised citric acid shall be dissolved in water, the volume shall be made up to 500 cubic centimetres, and the solution shall be added to the weighed portion of the sample in the bottle. To lessen the possibility of caking, the portion of the sample in the bottle may be moistened with 5 cubic centimetres of alcohol or methylated spirit before the citric acid solution is added ; and in that case the volume of the citric acid solution shall be 495 cubic centimetres instead of 500 cubic centimetres. The bottle shall be at once fitted into a

mechanical shaking apparatus and shall be continuously agitated during 30 minutes. The solution shall then be filtered through a large "folded" filter, the whole of the liquid being poured on the paper at once. If not clear, the filtrate shall be again poured through the same paper.

50 cubic centimetres of the filtrate shall be taken and the phosphoric acid shall be determined by the molybdate method prescribed below in paragraph (iv.) (*d*).

(*c*) *Total phosphoric acid.*

A weighed portion of the sample, in which portion, if necessary, the organic matter has been destroyed by ignition and the silica removed by appropriate means, shall be dissolved in nitric acid and boiled, the solution being made up to a definite bulk. The phosphoric acid shall be determined in an aliquot part of the solution by the molybdate method prescribed below in paragraph (iv.) (*d*).

(*d*) *Molybdate method.*

To the solution, which should preferably contain from 0·1 to 0·2 gram of phosphoric oxide ($P_2 O_5$), obtained as above described in paragraphs (iv.) (*a*), (*b*) or (*c*), 100 to 150 cubic centimetres of molybdic acid solution prepared as described below, or an excess of such solution, *i.e.*, more than is sufficient to precipitate all the phosphoric oxide present in the solution, shall be added, and the vessel containing the solution shall be placed in a water bath maintained at 70° C., for 15 minutes, or until the solution has reached 70° C. It shall then be taken out of the bath and allowed to cool, and the solution shall be filtered, the phospho-molybdate precipitate being washed several times by decantation and finally on the paper with one per cent. nitric acid solution. The filtrate and washings shall be mixed with more molybdic acid solution and allowed to stand for some time in a warm place in order to ascertain that the whole of the phosphoric oxide has been precipitated.

The phospho-molybdate precipitate shall be dissolved in cold 2 per cent. ammonia solution, prepared as described below, and about 100 cubic centimetres of the ammonia solution shall be used for the solution and washings. 15 to 20 cubic centimetres of magnesia mixture prepared as described below, or an excess of such mixture, *i.e.*, more than sufficient to precipitate all the phosphoric oxide present, shall then be added drop by drop, with constant stirring. After standing at least 2 hours with occasional stirring, the precipitate shall be filtered off, washed with 2 per cent. ammonia solution,

dried, and finally weighed as magnesium pyrophosphate. The filtrate and washings shall be tested by the addition of more magnesia mixture.

(*e*) *Preparation of Molybdic acid solution.*

The molybdic acid solution shall be prepared as follows :—

125 grams of molybdic acid and 100 cubic centimetres of water shall be placed in a litre flask, and the molybdic acid shall be dissolved by the addition, while the flask is shaken, of 300 cubic centimetres of 8 per cent. ammonia solution, prepared as described below. 400 grams of ammonium nitrate shall be added, the solution shall be made up to the mark with water, and the whole added to 1 litre of nitric acid (Sp. Gr. 1·19). The solution shall be maintained at about 35° C. for 24 hours and then filtered.

(*f*) *Preparation of Magnesia mixture.*

The magnesia mixture shall be prepared as follows:—

110 grams of crystallised magnesium chloride and 140 grams of ammonium chloride shall be dissolved in 1,300 cubic centimetres of water. This solution shall be mixed with 700 cubic centimetres of 8 per cent. ammonia solution, aud the whole shall be allowed to stand for not less than three days and shall be then filtered.

(*g*) *Preparation of the Ammonia solutions.*

The 8 per cent. ammonia solution shall be prepared as follows :—

One volume of ammonia solution of Sp. Gr. 0·880 shall be mixed with three volumes of water. This solution shall then be adjusted by the addition thereto of more strong ammonia solution or water as required until the specific gravity of the solution is 0·967.

The 2 per cent. ammonia solution shall be prepared as follows :—

One volume of 8 per cent. ammonia solution shall be mixed with three volumes of water.

(*v.*) *Determination of Potash.*

(*a*) *Muriate of Potash free from Sulphates.*

A weighed portion of the sample (about 5 grams in the case of concentrated muriate of potash or 10 grams in the case of low-grade muriate) shall be dissolved in water, the solution shall be filtered if necessary and made up to 500 cubic centimetres. To 50 cubic centimetres of the solution, placed in a porcelain basin, a few

drops of hydrochloric acid shall be added, and also 10 cubic centimetres or 20 cubic centimetres (according to whether the portion weighed was 5 grams or 10 grams) of a solution of platinum chloride containing 10 grams of platinum per 100 cubic centimetres. After evaporation to a syrupy consistency on a water-bath, the contents of the basin shall be allowed to cool and shall then be treated with alcohol of specific gravity 0·864, being washed by decantation until the alcohol is colourless. The washings shall be passed through a weighed or counterpoised filtered paper, on which the precipitate shall be finally collected, washed with alcohol as above, dried at 100° C. and weighed.

The precipitate is to be regarded as K_2 Pt Cl_6.

(*b*) *Salts of Potash containing sulphates.*

A weighed portion of the sample (about 5 grams in the case of concentrated sulphate of potash or 10 grams in the case of kainit or other low-grade salts) shall be boiled with 20 cubic centimetres of hydrochloric acid and 300 cubic centimetres of water in a half-litre flask. Barium chloride solution shall be cautiously added, drop by drop, to the boiling solution until the sulphuric acid is completely precipitated. Any slight excess of barium shall be removed by the addition of the least possible excess of dilute sulphuric acid. The liquid (without filtration) shall be cooled and made up to 500 cubic centimetres. A portion shall then be filtered, and 50 cubic centimetres of the filtrate shall be treated as in paragraph (v.) (*a*), 10 cubic centimetres or 20 cubic centimetres of platinum chloride solution, as the case may be, being used.

(*c*) *Potash in Guanos, and Mixed Fertilisers.*

Ten grams of the sample shall be gently ignited in order to char organic matter, if present, and shall then be heated for ten minutes with 10 cubic centimetres of concentrated hydrochloric acid, and finally boiled with 300 cubic centimetres of water. The liquid shall be filtered into a half-litre flask, raised to the boiling point, and a slight excess of powdered barium hydrate shall be added. The contents of the flask shall be cooled, made up to 500 cubic centimetres and filtered. Of the filtrate 250 cubic centimetres shall be treated with ammonia solution and excess of ammonium carbonate, and then, while boiling, with a little powdered ammonium oxalate, cooled, made up to 500 cubic centimetres and filtered. Of the filtrate, 100 cubic centimetres are to be evaporated in a platinum dish, and the residue heated, first in the air-bath and then very gently over a low flame, till all

ammonium salts are expelled, the temperature being carefully kept below that of low redness. The residue shall be treated with hot water, filtered if necessary, and the potash shall be determined in the filtrate as in paragraph (v.) (*a*).

Methods of Analysis of Feeding Stuffs.

4. The methods of analysis of a feeding stuff for the purposes of the Act shall be as follows :—

(*i.*) *Preparation of the sample.*

(*a*) If the sample is already in a fine condition, *e.g.*, a meal, it shall be thoroughly mixed, and a portion for the determination of the moisture shall be at once taken.

(*b*) If the sample is not in a fine condition, *e.g.*, a cake, it shall be carefully pulverised until the whole passes through a sieve with perforations from 2 to 3 millimetres in diameter. It shall then be thoroughly mixed, and a portion for the determination of the moisture shall be at once taken.

(*c*) From the sample thus prepared, a portion not less than 100 grams in weight shall be taken and further powdered if necessary and passed through a sieve with perforations of about one millimetre in diameter.

(*d*) If the original sample is appreciably damp, or if for any reason the operations of pulverisation and mixing are likely to result in loss or gain of moisture, the moisture shall be determined in this portion, as well as in the sample prepared as in paragraph (i.) (*b*), in order that the results of the analysis may be corrected to correspond with the sample in its original condition as regards moisture.

(*e*) Materials which cannot be conveniently pulverised or passed through a sieve shall be thoroughly mixed and sampled by the most suitable means.

(*f*) The prepared portion of the sample shall be placed in a stoppered bottle and from it the portions for analysis shall be weighed.

(*ii.*) *Determination of moisture* (*loss on drying*).

A weighed quantity of the sample shall be dried at 100° C.

(*iii.*) *Determination of oil.*

(*a*) A weighed quantity of the sample shall be placed in a Soxhlet thimble, which shall then be placed in the Soxhlet extraction tube and extracted with washed, re-distilled ether. At the end of 3 to 4 hours the thimble shall be removed from the Soxhlet tube, dried,

and its contents finely ground in a small mortar previously rinsed with ether. The substance shall then be returned to the thimble, the mortar being washed out with ether, and the extraction continued for another hour.

After evaporation of the solvent the oil shall be dried at 100° C. and weighed. The oil shall be re-dissolved in ether and any undissolved matter shall be weighed and deducted.

(*b*) In the case of samples containing saccharine matter, *e.g.*, sugar meals, the weighed portion in the Soxhlet thimble shall be washed twice with water, and then dried, previous to the extraction.

(*iv.*) *Determination of Albuminoids.*

The percentage of albuminoids shall be ascertained by multiplying the percentage of nitrogen by 6·25.

The determination of nitrogen shall be as follows :—

A weighed portion of the sample shall be transferred to a Kjeldahl digestion flask ; 10 grams of potassium sulphate and 25 cubic centimetres of concentrated sulphuric acid shall be added, and the flask heated until a clear liquid, colourless or of light straw colour is obtained. The operation may be accelerated by the addition of a small crystal of copper sulphate or a globule of mercury to the liquid in the digestion flask.

The quantity of ammonia shall be determined by distillation into standard acid after liberation with alkali, and, where mercury has been used, with the addition also of sodium or potassium sulphide solution.

The materials used shall be examined as to their freedom from nitrogen by means of a control experiment carried out under similar conditions with the same quantities of the re-agents which have been employed in the actual analysis, one gram of pure sugar being used in place of the weighed portion of the sample. The quantity of standard acid used in this control experiment shall be deducted from the total quantity of acid found to have been neutralised in the distillation of the sample.

Use of Prescribed Weights.

5. In calculating the results of analyses the atomic weights adopted by the International Committee on Atomic Weights shall be employed.

Forms of Certificates.

6. Every certificate which is affected by Regulation No. 3 of the Fertilisers and Feeding Stuffs (General) Regulations,

1906, and these Regulations, and which is dated on or after the first day of January, 1909, shall contain the following words :—

"The analysis was made in accordance with the Fertilisers "and Feeding Stuffs (Methods of Analysis) Regulations, "1908."

Short Title.

7. These Regulations may be cited as the Fertilisers and Feeding Stuffs (Methods of Analysis) Regulations, 1908.

In Witness whereof the Board of Agriculture and Fisheries have hereunto set their official seal, this ninth day of November, nineteen hundred and eight.

(L.S.) T. H. MIDDLETON,

Assistant Secretary

4, Whitehall Place, London, S.W.,
January, 1907.
Revised, February, 1910.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, *Whitehall Place, London, S.W.*

A pamphlet containing 10 *Leaflets dealing with Manures and Feeding Stuffs may be obtained from the same address, price* 1*d., post free.*

BOARD OF AGRICULTURE AND FISHERIES.

The Pea and Bean Weevils (*Sitones lineatus*, and *S. crinitus*).

The Striped Pea and Bean Weevil (*Sitones lineatus*). 1. Natural size. 2. Magnified.

Plants Attacked.

Peas and beans are very subject to attacks by the Pea and Bean Weevils, but the injury is frequently attributed to sparrows and slugs, because the weevils are not by any means easily seen, and readily fall to the ground when alarmed. The weevils eat the leaves and young shoots of the pea and bean plants, and the larvæ devour their roots. They are often most troublesome in market gardens and allotment grounds as well as in the fields, and in some years an extensive reduction in the crops of peas and beans has resulted from their attacks. They have also been known to attack sweet peas in gardens. *Sitones* seriously injure red clover in its early stages, and their small white maggots, or larvæ, also spoil "second cuts" of clover by eating the roots of the plants and stopping their growth. Trifolium, too, suffers considerably, particularly in its early stages, from the attacks of these weevils, although the injury is generally attributed to slugs and other insects. Reports of damage to lucerne have also been received, and one species attacks tares.

Description of the Beetles.

The commonest species is the Striped Pea Weevil (*S. lineatus.*) This is from one-fourth to one-fifth of an inch in length. Its ground colour is dark, but the body

is covered with greyish scales, which in some specimens are of a slightly greenish-grey shade. There are three lines of this grey, or grey-green, hue on the thorax, and many lines, lighter and darker alternately, on the wing cases. Some specimens are of a uniform colour. The antennæ are of a dull red colour, very slender, with club-like terminations. The legs are ferruginous, and the male has the anterior tibiæ curved and armed with a small hook. On the under surface the beetles are clay-coloured or dull grey, so that when they fall on their backs to the earth they can scarcely be detected.

Although not so abundant as the Striped Pea Weevil, the Spotted Pea Weevil (*S. crinitus*) also does much harm. It is smaller than *S. lineatus*, more of a grey or reddish colour, fresh specimens having almost a coppery sheen and with more or less distinct dark patches on the elytra. The bases of the legs are dark, the other portions dull red. Like the former it may be found almost uniform in colour, sometimes ochraceous grey, and may easily be known by its spotted elytra and by its often chalky appearance. It is somewhat local, and is particularly prevalent in the London district and on the South Coast. *S. crinitus* is very partial to tares.

Another species, *S. hispidulus*, is also common on clover in sandy districts, in some localities taking the place of *S. lineatus*. This weevil is black, covered with fuscous-brown scales, the thorax with three paler lines, the elytra with small black patches and stiff grey bristles; the eyes are flat, not prominent as in *S. crinitus*. In the South of England another species (*S. humeralis*) also occurs in numbers on trefoils. It resembles the previous weevil, but instead of erect bristles on the wing cases has a pale patch on each side of them. It has apparently a similar life-history to the Striped Pea Weevil.

Life-History.

The beetles lay their eggs either upon or just beneath the soil close to the roots of their food plants. The eggs hatch into small, white, footless, wrinkled grubs, with brown heads and biting jaws. These grubs feed on the roots of peas, beans, clover, sainfoin, and lucerne. When full-grown the larvæ are about one-fourth of an inch in length and pupate in an earthen cell. The pupæ lie in this cell—which is not lined with silk—at a depth of about two inches below the surface of the ground. At first the pupa is pale creamy-white; later the eyes become black and the proboscis-sheath darkens. The adult beetles hibernate in great numbers in barley ricks, and even, it is said, in barley stubble, but chiefly in hedgerows and other places. These hibernators

appear early in spring, attack the young peas and beans as soon as they appear above ground, and lay eggs on or near the roots. From these eggs larvæ appear, which from the end of May to the middle of June reach maturity and give rise to a summer brood of the beetles. A large number of these lay eggs which hatch into larvæ in the autumn; these live on the roots of clover, lucerne, &c., and feed there all the winter, doing considerable harm. The winter larvæ mature in May and appear as adult beetles in June. In some cases they have been known to come from the pupal condition as early as March. Thus the *Sitones lineatus* may live in one of two ways during the winter, either by hibernating in the adult form, or by feeding, in the larval stage, on the roots of clover, &c. The larvæ bore channels along the main roots of the plant and also seem to feed on the nodular growths found in the roots of leguminous plants.

The beetles are very active on the wing early in the year, especially on warm days, but they may also be found on damp foggy days well into autumn. In spring time they have frequently been noticed in numbers with the Bean Beetles (*Bruchus rufimanus*), on the blossoms of the gorse, and also on broom. The beetles eat out notches in the leaves of the young peas and beans and so interfere with the growth of the plant; in severe infestation the leaves may be eaten to the midribs. Warm dry weather and a rough tilth, especially the latter, favour these pests. When the weather is cold, the beetles shelter beneath clods, &c., and in dry weather even enter cracks in the ground. The habit of feigning death, so common amongst the weevils, is well shown in these species. As soon as the observer approaches them they fall to the ground on their backs, and lie as if dead until the danger appears to be past.

Methods of Prevention and Remedies.

(1.)—*Garden Cultivation.*—Lime, soot, or lime and soot mixed may be advantageously distributed over infested plants while the dew is upon them, or after rain. Finely-powdered guano may also be used in this way. An observer has found that, by covering the rows with fine earth, his peas have been kept free from this pest.

Spraying the rows of peas with arsenical washes has been found beneficial. Applications of weak mixtures of paraffin and water, with a little soft soap, would make infested plants distasteful to these insects.

Liquid solutions and finely powdered materials can be easily applied and well distributed with knapsack-machines.

When peas and beans are attacked, it would be desirable to press the soil tightly and firmly close round the plants, in order to prevent the beetles from coming up from the earth.

This might be done when the plants are young by men and boys walking with a foot on either side of each row.

(2.)—*Field Cultivation.*—An attack of these weevils may be materially lessened by running a light wooden roller over the peas when the ground is dry, so as to break down many of the rough clods, beneath which the beetles shelter in inclement weather. This should be followed by a good dressing of soot and lime broad-casted over the field.

Great numbers of beetles have often been noticed in carts used for carting barley, and amongst the refuse when barley is being threshed and during harvesting operations generally. Wherever possible the beetles should be collected, or swept together, and destroyed.

Summer-fallowing of land after an attack would be very desirable. Wheat after clover-ley is often infested by swarms of these weevils. In this case it would be dangerous to sow any leguminous crop. If it is sown the land should be "broad-shared," or cultivated and ploughed. The stubble should be burnt. The burning of stubble, weeds, roots, and rubbish is but seldom practised in these days, and it is believed that the infrequency of this practice is one cause of the more numerous and more destructive visitations of insects injurious to crops.

Infested clover leys should be deeply ploughed, with a "skim" coulter on the plough, and thoroughly well pressed. Roots on the top should be removed and burnt, not carted to the outsides and left in heaps.

4, Whitehall Place, London, S.W.,
May, 1895.

Revised, May, 1905.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

The Magpie Moth (*Abraxas grossulariata*).

1, Moth ; 2, Caterpillar ; 3, Cocoon. All natural size.

The caterpillars of this moth, called the "Magpie Moth" from its peculiar markings, often cause serious injury to the gooseberry and currant crops. They are sometimes also destructive to apricot trees, and are frequently found upon the plum, sloe, bramble, and hazel. The attacks of these caterpillars upon gooseberry and currant bushes are often confounded with those of the larvæ of the Gooseberry- and Currant-Sawfly, *Nematus ribesii*, but they are essentially distinct. The insects differ materially in every stage. In the winged state there are no points of resemblance, and in the larval conditions the *Abraxas* caterpillars are different in size, colour, and shape, from the grubs of the sawfly. Their habits also are distinct, for the caterpillars of the Magpie Moth live through the winter in the larval state, and are ready to attack the fruit bushes directly there is a vestige of green upon them, whereas the sawfly grubs are hatched from eggs laid by the female flies upon the leaves in the spring, and do not, therefore, appear until vegetation is well advanced.

When the Magpie Moth gets a footing in fruit plantations and gardens it is most important that active steps should at

once be taken to arrest its progress. Some years it is unusually prevalent and every year there is some complaint regarding it.

Description.

The Moth *Abraxas grossulariata*, which belongs to the *Geometridæ*, is a very pretty insect, nearly one inch and three-quarters across the wings, and over an inch long in the body. It varies greatly in colouring, but the typical moth has a yellowish body with a black spot on the thorax and a row of six black spots along its back. The fore wings have a white ground, with many black spots dotted irregularly upon them, with yellow blotches at their bases and an orange coloured band beyond the middle. In some specimens the black spots on the fore wings are almost confluent, while in others they are few and far between. The hinder wings are white with black spots round the margins, and other black spots placed irregularly upon them. The head is black, with short antennæ.

The egg is yellow and somewhat broad, with rows of dots upon it.

The caterpillar, when adult, somewhat curiously resembles the parent moth in its distinctive markings and coloration. It has a black head, and its body is whitish-yellow with a row of variously shaped large black spots along its back, and a row of much smaller black spots on the upper part of each of its sides. There is also a continuous band of a dark orange colour running from head to tail on each side, and below this another row of black spots, and two narrow black stripes underneath the body. The first two and last two segments are somewhat coloured with orange. There are three pairs of claw feet, which are black, and only two pairs of sucker feet, so that it progresses by a series of loops. It is an inch and a quarter in length when fully extended. The wintering larvæ of the first year are about half an inch long and much darker than the full grown larva.

The pupa is black and has three rings of a golden colour at the extremity, and other rings not complete. It is sometimes fastened to the leaves or stems by means of threads, or the caterpillar lets itself down to the ground and pupates there under leaves, weeds, or clods, and on walls.

Life History.

The Magpie Moth appears late in the summer, and places eggs upon gooseberry and currant leaves, near the midribs, in groups of three or four, or singly. In about 11 days the caterpillars come forth and feed for a brief period

upon the foliage, previous to their going into winter quarters.

From the smallness of the caterpillars and the age and condition of the leaves it is clear that this is not the time when the pests do their worst work. The caterpillars either spin leaves together and, ensconcing themselves in them, fall to the ground with the leaves, or they drop to the ground and get just under its surface. Where currant bushes grow against walls and fences in gardens, a favourite place for the larvæ to hibernate is in any crack or crevice between the bricks or boards. They also winter amongst the dead leaves that get caught up in the forks and burrs of the bushes. They thus remain in the larval state until the early spring, when they ascend the bushes, and proceed to devour the young and juicy leafage, doing at this time the greatest damage. When full fed, which is generally in late May and June, they turn into pupæ in a light cocoon, and the moths emerge in due time and place eggs upon the leaves of the gooseberry and currant bushes during August.

Methods of Prevention and Remedies.

1.—Warning is given of a coming attack of this insect by the appearance of the caterpillars in the autumn upon the gooseberry and currant bushes, showing that infestation may be expected in the following spring. When the caterpillars have been thus seen in the autumn, the ground beneath the bushes should be covered with finely powdered quicklime and dug deeply in the early days of winter. The fruit bushes should be previously pruned in order that any caterpillars that have "spun up" on the branches and shoots may be cut away or dislodged. If it is found after pruning that there are many caterpillars on the bushes it would pay to hand-pick them. All the cuttings from infested bushes should be collected and burnt. Winter washing with caustic alkali wash (*See* Leaflet No. 70) would destroy those hibernating in the forks.

2.—In the early spring, and before the leaves appear, the ground round the bushes should be hoed, the soil pulverized with prong hoes, and more lime, or a mixture consisting of two bushels of lime to one of soot, applied.

3.—Hand-picking may be also adopted in the spring in gardens and on small fruit farms where the measure is practicable. Spraying, however, is advisable.

4.—As the caterpillars of the Magpie Moth, like all larvæ of Lepidoptera, are mandibulate or biting insects, they should be destroyed by poisonous sprays such as arsenates. For this, arsenate of lead should be used. This spray must

not, of course, be employed on ripe or ripening fruit, but may be safely used at any time four weeks before the fruit is gathered. In the case of attack of the Magpie Moth caterpillar, the earlier the spraying is carried out the better, after the leaves have commenced to show. What would be better still in gardens and plantations where this pest occurs would be to give a heavy arsenical spraying in the autumn, about the first or second week in September, so as to kill the young larvæ soon after their exit from the egg, when they are most delicate.

4, Whitehall Place, S.W.,
October, 1895.

Revised, February, 1912.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 22 leaflets dealing with Insect and other Pests injurious to Fruit Trees and Bushes may be obtained from the same address, price 1d., or 9d. per dozen copies, post free.

BOARD OF AGRICULTURE AND FISHERIES.

Warble Flies (*Hypoderma lineata*, and *H. bovis*).

Fig 1

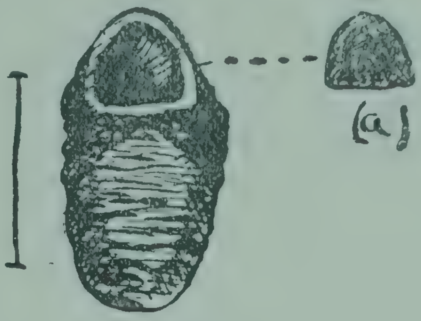


Fig. 3.

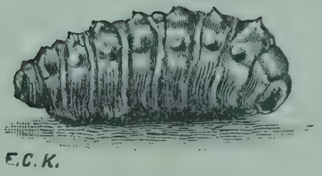


Fig. 2.

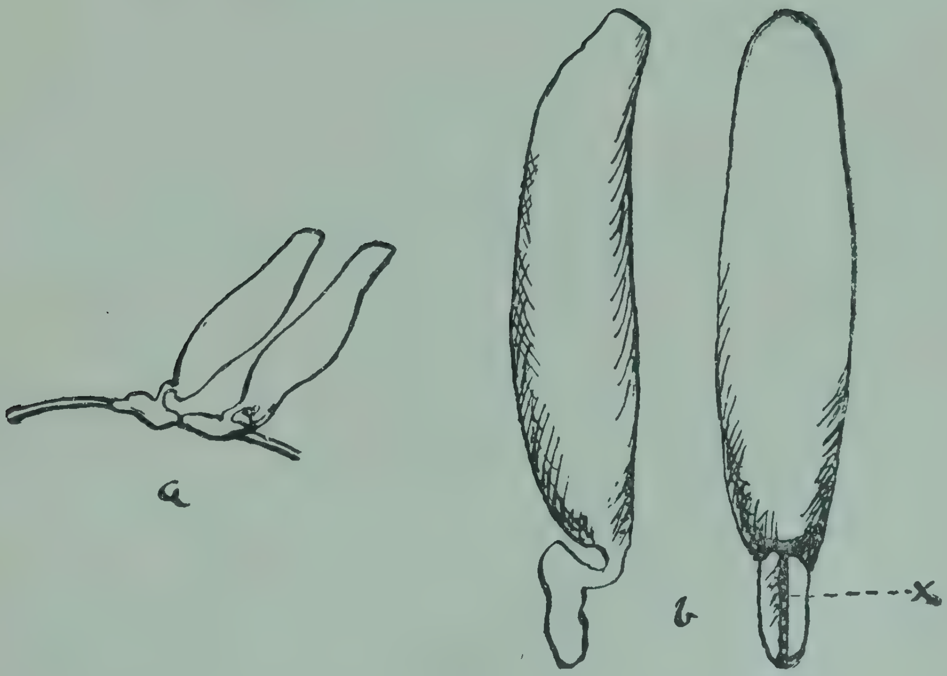


Fig. 4.

Fig. 1. Adult fly, *H. bovis*. Fig. 2. Puparium of *H. bovis*. Fig. 3. Puparium of *H. lineata*, shewing 'lid' (*a*). Fig. 4. *a*. Eggs of *Hypoderma lineata* on hair, magnified. *b*. Eggs still further magnified; x, clasper.

For many years past the Ox Warble Fly has been recognised as a serious pest in Great Britain. The damage done to the hides of cattle is enormous, a point to which the exhibits at certain Agricultural Societies Shows have recently drawn attention.

The Warble Fly that was supposed to occasion this loss was said to be the *Hypoderma bovis* (Degeer), but although this species occurs in this country it may not be the chief culprit. The common warble fly is probably *H. lineata* (Villiers), and from observations made during the year 1902 the greatest amount of damage seems to be done by this species.

The damage caused by these pests is due both to the adult flies and to their larvæ or 'bots.' The flies, when on the wing and on the look out for a host on which to deposit their eggs, frighten stock and frequently cause loss amongst 'in-calf' cows by making them stampede about the fields. The galloping about is also bad for milch cows not only because it affects adversely the secretion of milk, but also because of the bruising of the udders due to their striking against the body. The maggots or 'bots' living beneath the skin are a source of irritation to the cattle, while there is also loss from hides ruined, by the perforations, for tanning purposes. They also cause loss to the butcher, who often finds the flesh beneath the 'warbled' areas so altered by the inflammation set up by the parasites that the beef in that region is spoiled. This so-called 'licked beef' has a straw-coloured, jelly-like appearance in a newly slaughtered carcase, but turns to a dirty green in a few hours.

Description.

The *Oestridae*, to which these Warble flies belong, comprise a family of two-winged flies or Diptera, all of which are parasitic in their larval stage, upon or within various mammals.

Hypoderma lineata.—The egg is of a peculiar shape (Fig. 4) and is about $\frac{1}{12}$ of an inch long.

The mature larva or bot is greyish-brown with grey stripes and is about an inch in length, the body being very spiny.

The perfect insect is half an inch long, very hairy, black, clothed with almost white, reddish-brown, and black hairs; there are white hairs on the head and thorax and forming a band at the base of the abdomen. There are also blackish-brown hairs on the upper part of the head, the thorax, the legs and the middle region of the abdomen.

The 'bots of *H. bovis* are easily distinguished from those of *H. lineata* by the two last segments of the body being free from spines, whilst in *H. lineata*, the last segment only is bare. The mature bot of *H. lineata*, when it leaves the host, is greyish-brown, striped with grey or white; in *H. bovis* it is brownish and much more contracted and

rounded. The adult *H. bovis* (Fig. 1) differs in regard to colour and size, being slightly larger than *H. lineata* and banded with yellow and velvety black hairs, not brownish-black as in *H. lineata*. Like the former it appears from May to September.

Life History.

The life history of *Hypoderma lineata* is as follows :—The fly deposits her eggs upon the hair of the beast, particularly on the legs, just above the hoofs, whence a common name for this fly in America—the heel-fly ; but they are also placed elsewhere. The eggs are fastened to the hairs, usually several together ; each egg is firmly attached to the hair by a process which clasps the hair immediately the egg is laid by the female. The animal licks the place where these eggs are placed, and the larvæ hatched from them are carried by the tongue into the mouth. The young maggots which are spiny pass into the gullet or œsophagus and soon penetrate its walls. They then moult their skin, becoming smooth, and proceed to wander through the connective tissues of the host and between the skin and flesh to the back, under the hide of which they are at last found. Here they moult again, once more becoming spiny. At this stage they commence to produce considerable irritation, and a swelling arises over them—the warble—which soon becomes perforated by a hole at the summit. The tail end is pointed towards this aperture, the two spiracles or breathing pores situated on it being placed close to the opening. There is now formed much pus, upon which, together with blood, the larval bot feeds and develops. A last moult takes place before maturity. By means of the spines the maggot makes its way out of the warble-cell and falls to the ground.

The larva then enters the pupal stage, which may take place either in or on the ground, or under some stone, &c., lying upon the ground. The puparium, or pupa-case, is formed by the bot's old skin, which hardens and gradually becomes almost black in colour. In from three to six weeks the fly escapes from this case, through a circular opening or cap in the puparium (Fig. 3).

This fly appears in Great Britain from the middle of May until the beginning of September

The life history of *H. bovis* is not known with certainty. It may be the same as *H. lineata*. It is said however to lay its eggs on the upper parts of the body. According to Miss Ormerod the maggots from these eggs, aided by mouth hooks and spines, bore directly through the hide. These grow into the mature bots and cause warbles similar to the former species.

All these *Oestridae* are found on the wing during hot, bright weather only. They are most active during the

hottest part of the day, usually between 12 and 3 o'clock. They do not fly in dull cold weather, but become torpid, sheltering in crevices of sheds, hurdles, under leaves, &c. So susceptible are they to temperature that they will not fly into shade or over water. The adults have their mouth parts either quite abortive, or rudimentary, and hence may take little or no nourishment. They produce when flying a low audible hum, which causes the animals to stampede and to seek shelter.

Prevention and Treatment.

1.—Much good may be done by allowing stock to have plenty of shelter during hot weather, either natural shelter of trees or artificial shelter formed by rough lodges or sheds.

2.—The proximity of water, which the stock can enter at will, is also useful as a means of warding off the pest.

3.—The flies may be deterred from laying their eggs by dressing the beasts at intervals of a month, from May to September, with some strong smelling oil or grease. Cart grease and paraffin may be used for this purpose. Another mixture found of benefit is 1 quart of train oil, 4 ozs. of oil of tar, and 4 ozs. of flowers of sulphur.

4.—If animals are found to be warbled the 'bots' may be squeezed out of the swellings and killed during February, March, and April. The maggots may be very easily extracted by squeezing the warbles with both thumbs, and may then be squashed under foot. This is a better plan than covering the opening of the warble with grease or mercurial ointment, so as to suffocate the bot within.

4, Whitehall Place, London, S.W.
September, 1894.

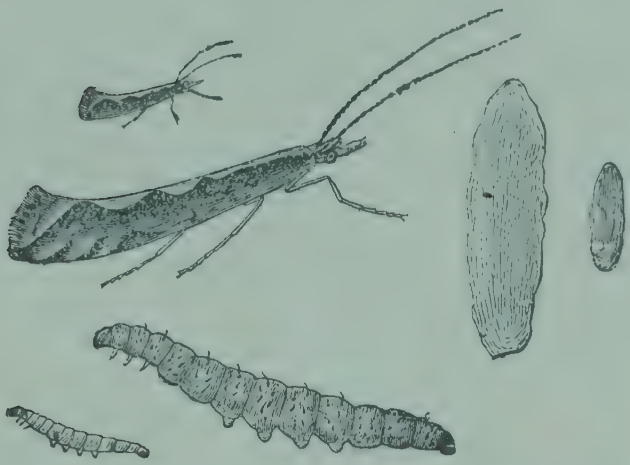
Revised, July, 1905.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

The Diamond-back Moth (*Plutella maculipennis*, Curtis).

Fig. 1.



The moth and caterpillar, natural size, and magnified. The cocoon, natural size, and magnified.

The caterpillars of this pretty little moth have in some seasons caused considerable injury to turnips, swedes, cabbages, kale, and other plants of the group *Brassica*. The caterpillars congregate upon the leaves, on their under surfaces for the most part, and soon devour every particle of their soft tissues, so that either the plants are killed outright or they are so much injured that the crop is materially reduced. A field of turnips or swedes badly infested with these caterpillars has a most peculiar and ghastly appearance, especially when the sun shines upon the riddled and whitened leaves.

This insect has been noticeably injurious to the turnip crop in Great Britain in 1837, 1851, 1883, and 1888. In 1891, however, there was a most serious attack both in England and Scotland, principally in the eastern counties, from Kent to Aberdeenshire. There were attacks in many other parts of Great Britain in 1891, but not nearly of the same gravity and extent as in the eastern districts, where whole fields of turnips, swedes, rape, and cabbage were completely ruined by the hordes of caterpillars infesting their leaves. Cabbages particularly were sadly affected by these pests; they swarmed between the leaves covering the "hearts," and soon caused them to rot. In 1901 also the caterpillars did much damage from July onwards.

The first notes of alarm with regard to the grave infestation of 1891 were heard about the beginning of July, and by the middle of that month great anxiety was felt by many farmers as to the fate of their turnip and cabbage crops, for the caterpillars were clearing everything before them with startling rapidity. On account of their increasing ravages the Board of Agriculture made an exhaustive inquiry into the circumstances and extent of the attack, and instituted a series of special experiments as to the value of various remedial measures which were conducted in different parts of the most seriously infested districts towards the end of July.* Fortunately, about that time and during the first part of August, heavy and continuous rain fell, accompanied by low temperature, which caused fatal disease in the caterpillars, or washed them from the plants, and checked their progress. The rain at the same time stimulated the growth of the plants.

Description of the Insect.

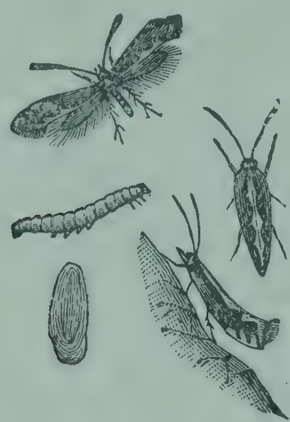


FIG. 2.

Moth flying, natural size; Moths resting, natural size; Caterpillar and cocoon, natural size.

The Diamond-back Moth belongs to the family *Plutellidæ* of the extensive group of moths known as *Tineina*. It has been wrongly known for years as *Plutella cruciferarum*, Zeller, but Curtis had previously described it in 1831 under the name *maculipennis*. It is from five lines to half an inch long when resting with folded wings, as shown in two of the figures. The wings when expanded have a breadth of nearly two-thirds of an inch. The prevailing colour is light brown shaded with grey, with the "diamond" marks plainly visible upon the back when the moth is at rest. The hind edge or margin of each fore-wing has three white marks, and these, on the margins of the wings being brought together when the moth is at rest, form the diamond marks. In this position of rest the peculiar tilt of the wings at their ends, forming a kind of tuft, is a notable characteristic. In

* Special Report on the Attack of the Diamond-back Moth Caterpillar, 1891.

some specimens the grey or ashy grey shades prevail over the brown. The under surface of the body is of a grey or pale grey hue.

The fore wings, shown expanded in Figure 2, are greyish brown with dark spots. Along the inner margin of the fore wings there is a border of light colour. The narrow hinder wings are more silvery-grey and have long fringes. The moth has greyish legs, and long slender antennæ of a white colour.

The egg is white or yellowish white, cylindrical, and marked with elaborate and most delicate tracery.

The caterpillars are half an inch long. They have 16 feet and are green in colour, with greyish heads when full grown, but in their early life are grey with dark heads. Their bodies are somewhat "spindleshaped," as Curtis puts it: that is, they taper off at the head and tail ends. Upon some of the segments of their bodies there are a few bristles.

The chrysalids are enwrapped in creamy yellow cocoons, of a fine net-like texture more or less open at each end, one end being closed by the cast larval skin. Stripped of the cocoon the chrysalis is white or yellowish white, with dark marks upon it, at least, in its latest stages. In the earlier stages the colour is darker.

Life History.

In the spring the first brood of moths comes from the chrysalids which have wintered upon the stalks and dead leaves of weeds, such as Charlock, Hedge Mustard, Jack-by-the-Hedge, and similar plants, upon *Cheiranthus* or wall-flower, especially the common variety, which grows freely upon cliffs by the sea, and also upon the Prickly Saltwort, *Salsola Kali*, a common seashore plant. The chrysalids, snugly packed in silken cocoons represented in the figures, are also found on dead stalks and rubbish near the food plants of the caterpillar. When the first brood of moths appears, the females lay eggs upon the under sides of the leaves of wild cruciferous plants, and on the leaves of such cultivated varieties of them as are then growing. There is no reliable record as to the time when the caterpillar comes from the egg, but the caterpillar stage lasts from 20 to 28 days, and the chrysalis stage of the first broods about 15 days.

Curtis and some other authorities hold that there are more than two broods, or generations, of this insect if the weather is favourable; this was demonstrated in 1891, and it may be concluded that there are two and more broods in a season if the conditions of climate are suitable. Food supply is only a secondary condition affecting the multiplication of these insects, as there are so many plants upon which the larvæ may be supported; for instance, all kinds of turnips, all kinds of cabbage, broccoli, Brussels sprouts, kale, rape,

mustard, wild mustard, radishes, horse radish, stocks, wallflowers, rockets, penny cress, shepherd's purse, scurvy grass, and wall mustard, all of which are crucifers, and on saltwort, which belongs to the Chenopodiaceae.

Remedies and Methods of Prevention.

1.—From the experiences of 1891, and as the result of many experiments carried out then, dressing the infested plants with soot and lime mixed together appears to be the best remedy.

This should be put on by means of a distributing machine, at the rate of from two to six bushels per acre, the proportions being one part of lime to three parts of soot. This pungent substance should be distributed with regularity and force over, through, and under the leaves, and upon the bodies of the caterpillars.

2.—Sprayings with pungent substances, such as carbolic acid and paraffin, applied with a distributing machine in the smallest quantities, or paraffin emulsion in larger quantities, have been found to be efficacious in some degree, but not so effectual as soot and lime.

3.—Soot and sulphur, in the proportions of one bushel of soot to three or four pounds of sulphur, put on at the rate of from two to four bushels per acre by a distributing machine, have been found useful in some cases.

4.—Broadcasting soot and lime, or soot and sulphur, upon infested plants checks the caterpillars to some extent. This must be done when the dew is upon the plants, and much larger quantities are required per acre than when a distributing machine is used. It is, however, not very satisfactory, as the mixture does not go under the leaves, where the caterpillars are.

5.—Horse hoes with branches of birch, green broom, furze, or any elastic boughs, fastened to their sides, may be drawn between the rows advantageously, so as to brush the plants and dislodge the caterpillars upon them. Another horse hoe should follow at once to bury or crush the dislodged caterpillars.

6.—When plants are found to be infested, nitrate of soda, guano, or other forcing manures should be applied to stimulate growth.

7.—After an attack of this insect it is most desirable to brush hedge sides and hedge rows, ditches, and other places harbouring weeds, in the early spring, as it has been noticed that the attack has often been commenced in corners and other parts of fields bounded by hedge rows, and has spread over the fields. Many of the moths may be often seen around cruciferous weeds on the hedge sides. Charlock is a favourite resort of these insects.

Natural Enemies.

In 1891 it was noticed that many of the caterpillars of the Diamond-back moth were attacked by parasites and destroyed by other insects.

Foremost among these was a species of the *Ichneumonidæ* called *Limneria gracilis*, Gravenhorst.

Fig 3.

Limneria gracilis, Gravenhorst: Male and Female Flies, natural size and magnified.

The female fly places an egg in the body of the caterpillar, upon which the larva from this egg feeds. The late Mr. Stainton, writing in August 1891, concerning the great number of the parasites that were in evidence, said: "Probably the parasites of the Diamond-back moth will this "year be developed in such numbers that the moth will be "almost annihilated in 1892."

It was noticed in 1891 that various kinds of birds were effective enemies of the caterpillars of this moth. Among these were rooks, starlings, peewits, golden plovers, and sea-gulls, and it was stated that where small birds had been exterminated the damage was worse. This is one more reason for endeavouring to preserve harmless and useful birds.

4, Whitehall Place, S.W.
June, 1894.

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Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 23.

BOARD OF AGRICULTURE AND FISHERIES.

Potato Disease (*Phytophthora infestans*, De Bary).

This disease, well termed by agriculturists *the* "potato disease," has in the past been the cause of immense loss, and is at the present day the chief trouble with which potato growers have to contend.

Description and Life History.

The first sign of this disease is the presence of yellowish spots on the leaves. These spots gradually increase in size and become brown, this condition being followed by the curling of the leaves. If the under surface of a diseased leaf be examined with a magnifying glass, the fruiting branches of the fungus will be seen forming a delicate white mould.

The spores of the fungus are exceedingly numerous and minute, and are scattered by wind, or by ground game and other animals running amongst the plants. When it is stated that every spore brought into contact with a damp potato leaf is capable of starting a new centre of infection, the rapid spread of the disease under favourable conditions will be readily understood. The disease develops and spreads with the greatest rapidity during damp, warm weather, such as often occurs in July.

Spores that fall to the ground are washed into the soil by rain and may infect young potatoes, especially those growing near the surface. It is probable, too, that the mycelium of the fungus passes down diseased stems into the young potatoes. If the season be wet and warm, the mycelium present in the potato continues to grow, soon causing brown spots to appear, and ending in the rotting of the tuber. On the other hand, if potatoes that are infected be kept dry, the mycelium in their substance may remain stationary until the following spring, when it may commence growth and infect the new crop, finally appearing in the fruiting condition on the leaves.

Preventive and Remedial Measures.

1.—Potato disease is propagated and carried on from season to season in the sets. It is therefore of the utmost importance that sound crops only should be kept for seed and that sets should be stored under the most favourable conditions. In an ordinary way seed potatoes should be carefully selected, all those being rejected that show the least sign of taint; they should be allowed to get thoroughly dry before clamping and should be stored separately from the ware.

2.—Diseased haulm should be removed and burned before the potatoes are lifted. If the disease appears late in the season when the tubers have attained a fair size, much benefit may be derived by pulling the haulm at once.

3.—Potatoes are found to become less resistant to disease the longer they have been in cultivation, and therefore a good new strain is to be preferred to an old stock ; but most of the new varieties offered for sale are more susceptible to disease than old stocks of the best kinds, and growers are warned against relying on the disease-resisting power of a potato merely because it is a recent introduction.

A change of seed is desirable if sets from a sound crop can be obtained, because of the increase in the total crop of sound tubers which is likely to follow, but it must not be supposed that changing seed will enable the plant to withstand disease. On the contrary, it is often found that the luxuriant growth of haulm which may result from changing seed renders the crop more susceptible, and that the percentage, though not the actual weight, of sound tubers is reduced.

4.—The rows of potatoes should be well "earthed" or "banked" up, as the thicker the layer of soil the less chance is there of the spores of the fungus reaching the young tubers.

5.—Neither the planting of vigorous varieties nor cultivation can be trusted to ward off the disease in a wet season, but spraying with Bordeaux mixture has been found effective and is now part of the regular routine of cultivation in humid districts. Even in dry seasons when no disease is apparent the treatment is found to be beneficial, producing a longer period of growth and an increased yield. This is so widely recognised that spraying has become general in several potato-growing districts, whatever the season promises to be. As the disease does not as a rule make much headway before the end of July, spraying is seldom wanted for the first early sorts, the leaves of which will be dying down before any great harm is done.

Bordeaux mixture may be prepared in different ways; some useful methods are described in the following pages.

Ordinary Bordeaux Mixture.

Sulphate of copper or "bluestone"	12 lb.
Freshly burnt quicklime	8 lb.
Water	75 to 100 gals.

In order to obtain good results from Bordeaux mixture careful attention must be given (1) to the materials employed, and (2) to the preparation.

1. *Materials.*—Copper sulphate of 98 per cent purity should be obtained. "Agricultural" copper sulphate, which usually contains iron sulphate, must be avoided. Iron sulphate or copperas is valueless for this purpose.

An easy test for the presence of iron in the copper sulphate is to dissolve a little in water and add ammonia with constant stirring until a deep blue liquid forms; any quantity of brown flocks floating about in this blue liquid indicates the presence of so much iron that the material should be subjected to a proper analysis previous to use.

The lime used should be white "fat" lime from the mountain limestone or chalk, the kind of lime which is used by plasterers. It must be freshly burnt. If of good quality 8 lb. will be sufficient for use with 12 lb. of copper

DISEASED LEAF AND TUBER OF POTATO.

sulphate, but the weight of lime required depends upon the quality, and while as little as 6 lb. might be sufficient in one case, as much as 12 lb. might be required in another.

2. *Preparation.*—The lime should always be diluted with a large quantity of water before the solution of copper sulphate is added, otherwise a very inferior mixture will result. When making a small quantity the best plan is to dissolve the copper sulphate in about one-sixth of the water, mix the lime with the remainder and then pour the copper sulphate solution into the milk of lime; but when a large quantity of spray has to be prepared it is usually much more convenient to make a somewhat concentrated mixture and to dilute immediately before application to the crop. Under no circumstances, however, should the first mixture be made too strong, and when 12 lb. of copper sulphate and 8 lb. lime are to be employed, the first mixture should fill a 40 gallon cask. To make the mixture proceed as follows:—Run into a cask about 30 gallons of water. Next moisten and slake 8 lb. of lime—the lime must be allowed to swell and crumble slowly; when it has been well slaked, work it down first into a thick cream and gradually dilute to 4 or 5 gallons. The milk of lime must next be strained through a fine sieve or piece of sacking to remove grit, when it should be poured into the cask containing the 30 gallons of water. Now crush 12 lb. of copper sulphate, dissolve in 5 gallons of hot water, and pour the solution into the cask containing the milk of lime. As the two fluids mix they must be gently stirred. If the lime has been slaked slowly and the whole process has been carried out as indicated, a gelatinous precipitate forms in the cask—that is, the water becomes filled with starchlike flecks; these remain in suspension for a long time. On the other hand, if too little water has been employed, or if the lime has not been properly prepared, or if stirring has been neglected, a comparatively coarse powder forms in the mixture and soon settles, so that after standing for an hour or two the fluid in the upper part of the cask is quite clear. The starch-like precipitate, when once it dries on foliage, adheres closely for months, whereas the coarser powder which results from careless preparation washes off readily, so that the leaves lose much of their protection after the first heavy rain, and spraying does little or nothing to check disease. The concentrated mixture of 40 gallons should be applied as described on p. 5.

"*Safety*" *Test for Bordeaux Mixture.*

In the manufacture of Bordeaux mixture it is most important that the right quantity of lime should be used. If too little is employed, the mixture will injure foliage; if, on the other hand, too much is used the fungicidal value of the mixture is reduced. The following test will show whether sufficient lime has been employed.

Remove some clear fluid from the surface of the Bordeaux mixture, and add to it a small fragment of pure potassium ferrocyanide (a substance which may be procured through

the local chemist at a cost of 3*d*. to 4*d*. per ounce). If the mixture is ready for use no change occurs, but if too little lime has been used a deep chocolate-red colour will result, and more milk of lime should be added to the mixture until no red colour is obtained on testing a sample removed as described.

Bordeaux Mixture made with Lime Water.

A method of manufacturing Bordeaux mixture which much reduces the cost of spraying, is recommended in the Eleventh Report of the Woburn Experimental Fruit Farm.* This consists in the use of lime water in place of milk of lime for mixing with copper sulphate, and is regarded as being at least twelve times more efficient than ordinary Bordeaux mixture. While lime water prevents copper sulphate from injuring foliage, it interferes less with its fungicidal properties than milk of lime does; hence the quantity of copper sulphate may be much reduced.

The ingredients required for making 100 gallons of the Woburn Bordeaux mixture are, approximately:—Copper sulphate, $1\frac{1}{4}$ lb.; Lime-water, 17 gallons; and soft water to make up to 100 gallons. It is believed that the fungicidal value of this preparation would be about equal to that of the ordinary Bordeaux mixture given on p. 2, when 75 gallons of water are used. The water used should in all cases be soft.

To make lime water $\frac{1}{2}$ to 1 lb. of good quicklime should be slaked and then placed in 30 gallons of soft water, and stirred at intervals, when the mixture may be allowed to settle until the fluid is quite clear. The clear fluid is lime water, and may be carefully run off without disturbing the sediment.

The lime water method of manufacturing Bordeaux mixture has been in use in Italy since 1886, but in France and America the use of milk of lime is preferred.

Application of Bordeaux Mixture.

When Bordeaux mixture has been made it should be diluted if necessary and used without delay. One or two days' supply only should be made at a time, for though well-made Bordeaux mixture will keep fairly well for several days, it is best used within 48 hours.

For spraying potatoes under favourable conditions the mixture, if made in a concentrated form as described on p. 4, should be diluted to 100 gallons, but when spraying must be done in damp weather it should be diluted to from 75 to 90 gallons. Before pouring into the sprayer it should be stirred thoroughly. If possible a sprayer provided with a dasher or other contrivance for keeping the mixture agitated should be used. If no mechanical contrivance is available stirring should take place frequently while the work is in progress.

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* By the Duke of Bedford, K.G., and Spencer U. Pickering, F.R.S., 1910.

The amount to be applied per acre varies with the quantity of haulm in the crop to be treated, but is usually from 100 to 150 gallons, where the foliage is fully developed. The plants must be sprayed from underneath, as well as from above, so as to reach the fungus on the under side of the leaves. Machines can be obtained which spray the plants from below.

The cost of a single spraying need not exceed 8*s.* per acre, and, with certain horse machines, 30 acres can easily be treated in a day. Bordeaux mixture does not begin to work until several days after it has been applied, and it must therefore be used some time before any symptoms of disease are to be expected, say towards the end of June, or early in July, according to the locality and season. The crop should be sprayed twice at least. The first spraying should take place as soon as there is a good development of haulm, the treatment being repeated about three weeks later when the growth is complete. If only one spraying is given it should take place about the middle of July.

NOTE.—Sulphate of copper compositions are poisonous, and the tubs, pails, or other vessels which have contained Bordeaux mixture, or in which it has been made, must therefore not be used for farm animals.

Other Leaflets dealing with fungus diseases of potatoes are No. 105 (*Black Scab of Potatoes*); No. 117 (*Black-Leg or Potato Stem-Rot*); No. 137 (*Potato Scab*); No. 164 (*Potato Leaf-Curl*); No. 193 (*Winter Rot of Potatoes*); and No. 232 (*Corky Scab of Potatoes*).

4, Whitehall Place, London, S.W.,
July, 1894.
Revised, December, 1910.

Leaflet No. 24.

BOARD OF AGRICULTURE AND FISHERIES.

The Ribbon-Footed Corn-Fly (*Chlorops tæniopus*, Mg.).

The larvæ, or maggots, of the Ribbon-Footed Corn-Fly, which is sometimes termed the "Gout Fly," in some seasons cause an immense amount of harm to wheat and barley plants. In 1893, particularly, the injury it occasioned to the barley crop was most serious, mainly because the plants were kept in a backward condition by the extreme drought, so that they could not grow away from the attack of the larvæ within them. Many hundreds of acres of barley were fed off with sheep, as the plants were so injured that they could not possibly recover and yield a crop. In many cases the yield of infested fields was next to nothing, the plants being stunted and distorted, as shown in Fig. 5, and the ears were unable to emerge from the sheathing leaves.

Symptoms of Attack, and Damage done.

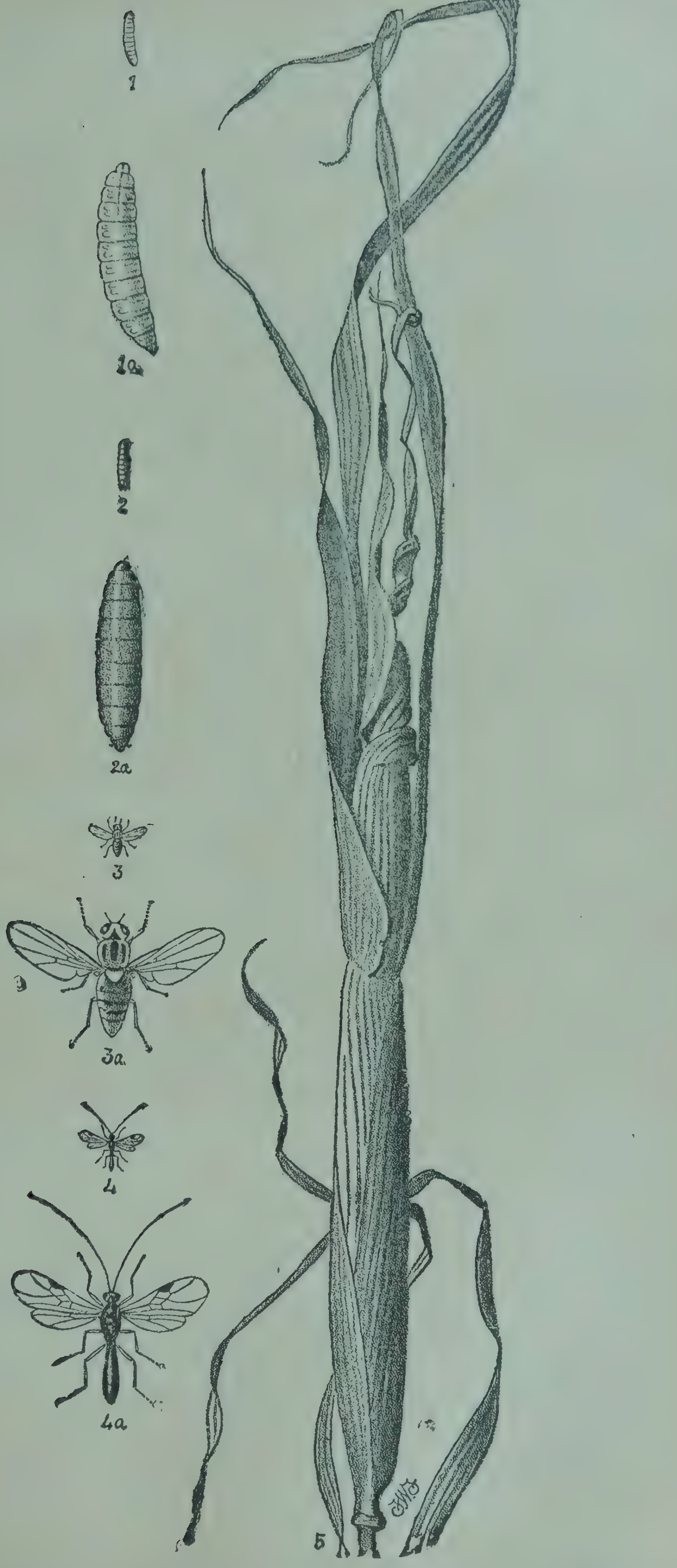
In plants infested by the larvæ the ear is eaten away at its base, and the stem is channelled to the first node or joint below the ear. The ear is checked in its growth and fails to push out through the surrounding leaves, the shoot showing a characteristic gouty or distended appearance. When climatic conditions are favourable and forcing manure is applied the infested ear can escape from the sheathing leaves and produce some grain, but in a season such as 1893 was, this does not take place. Although only one larva may have been present in the stem, if the environment has been unfavourable for growth the whole ear may be spoiled.

Description.

The fly is very small, being only about one-sixth of an inch long (Fig. 3, natural size, Fig. 3*a*, magnified) and one quarter of an inch in spread of wings. The head is yellow, with a black triangle on its upper surface; the antennæ are black; the thorax is yellow, with three prominent longitudinal black stripes on its upper surface; and the abdomen is yellow, with dark-brown transverse markings or stripes. The eyes are large and green. The male is rather smaller than the female, and of a light yellow hue, the female being of a somewhat greener colour; the hind end of the male is rounded, that of the female pointed.

The eggs are elongate oval, and greenish white in colour; they have a longitudinal groove on one side.

The larva (Fig. 1, natural size, Fig. 1*a*, magnified) is legless; it is white in colour, becoming slightly yellow in time. It is



Chlorops tæniopus.—Figs. 1 and 1*a*, larva ; figs. 2 and 2*a*, puparium ; figs. 3 and 3*a*, the fly. Figs. 4 and 4*a*, *Cœlinius niger*. All nat. size and

from a fifth to a quarter of an inch in length when full grown; it has two mouth hooks, and at the other end two spiracles.

The puparium (Fig. 2, natural size, Fig. 2*a*, magnified) is brown and somewhat flattened.

Life History.

The flies appear in May and June, and lay their eggs on the leaves surrounding the young ears that are still surrounded by the sheathing leaves. The maggot on hatching passes inwards to the stem at or just below the ear. Here it feeds. It then tunnels the stem down to the first node, and here or in the folds of the leaves encircling the spoiled ear it changes to a pupa, by July. A new brood of flies issues from August onwards, the eggs of these flies being laid on wild grasses, or on the lately-sown wheat or winter barley. It was only ascertained positively in 1890 that these crops were infested in this country in the autumn, although it had been well known for a long time that in Germany, Holland, and France the Ribbon-Footed Corn Fly passes the winter in corn plants.

Treatment.

1.—Early spring sowing of barley in infested districts is an important preventive measure.

2.—In autumn, sowing should take place as late as possible, so that the late brood of flies may find no young plants to lay their eggs on.

3.—Couch and other grasses should be kept down.

4.—Wheat or barley should not be sown close to fields that have been infested.

5.—After thrashing an infested crop all refuse should be burnt.

Natural Enemies.

From a large percentage of the pupa-cases of the Ribbon-Footed Corn-Fly kept in glass-covered boxes, a parasitic hymenopterous fly came forth. This fly (Fig. 4 natural size, 4*a* magnified) is known as *Cœlinius niger*, a pretty brown insect about a quarter of an inch long, with brilliant wings. In the body of the corn-fly larva it places an egg, from which a larva is hatched, and feeds upon its host.

There is another fly, *Pteromalus micans*, which is parasitic in a similar manner upon the Ribbon-Footed Corn-Fly, and is described by Curtis as being very destructive to it.

4, Whitehall Place, London, S.W.
August, 1893.

Revised, May, 1908.

BOARD OF AGRICULTURE AND FISHERIES

Chafer-beetles *or* White-grubs.


A B C

FIG. 1.

The Large Cockchafer (*Melolontha vulgaris*).

A. Perfect insect ; B. Larva ; C. Pupa. All natural size.

Distribution and Plants attacked.

In the majority of districts in Great Britain "Chafer-grubs" or "White-grubs" are more or less abundant. The damage they do in the larval or grub state is often very serious, but is perhaps more frequently attributed to the work of the wire-worm. Not only do these insects cause loss to the farmer, gardener, and forester by damaging the roots of plants when in the grub stage, but much harm is also done by them when they appear as adult beetles. The beetles feed on the leaves of various forest trees, occasionally quite stripping them of their foliage, particularly broad-leaved species, although conifers are also attacked. Fruit trees are occasionally attacked by them, as also are grass, corn, peas, and many vegetables. It has usually been supposed that this loss is due to the Large Cockchafer (*Melolontha vulgaris*), but this large chafer is no more abundant and harmful than two smaller species known as the Garden-chafer, Bracken-clock or Coch-y-bonddu (*Phyllopertha horticola*), and the Summer-chafer (*Rhizotrogus solstitialis*).

These insects are much more abundant and destructive in France, Germany, and other parts of Europe than in Great Britain ; but as during the past ten years they have very materially increased in this country, farmers and gardeners should guard against them wherever possible. The grubs feed on almost any roots, but are particularly prone to attack those of grass and seedling trees. Young oaks and pine-trees

often suffer severely both in this country and on the Continent. The grubs bite the roots, thereby checking the growth of the plants and frequently killing them outright. In grass land, the grass may often be seen dying from the ravages of these pests. Rooks are very fond of white grubs, and are attracted to the fields to feed on them; these useful birds are often unjustly accused of injuring the grass plants, whereas they are really feeding on the chafer-grubs which destroy the grass. The beetles are perfectly easy to distinguish from one another, but the grubs of all three are very similar when young, and can only be identified by microscopic examination. This is a somewhat important matter, as there is a difference in the life-histories of the three species in regard to the time of appearance of the adults and the duration of the grub stage. It is important to notice the time of appearance of the adult beetles, as the pests are then easiest to destroy; they are very difficult to combat when in the grub stage in the ground, especially in grass-land.

FIG. 2.

a. The Summer-chafer (*Rhizotrogus solstitialis*). *b.* The Garden-chafer (*Phyllopertha horticola*). *c.* The Green Rose-chafer (*Cetonia aurata*). *d.* Larva of the Garden-chafer. All natural size.

Description.

(1) The *Large-chafer*, usually called the *Cockchafer* (Fig. 1—A, B, C), is often an inch in length, with head and front portion of the body black, the wing cases (elytra) being reddish-brown, hairy, and with five raised lines on each; along each side of the abdomen are five white triangular marks. The abdomen ends in a prolongation, downwardly curved, and not covered by the elytra. The end joints of the antennae form a kind of club, made up in the male of seven leaves and in the female of six.

(2) The *Summer-chafer* (Fig. 2—*a*) is somewhat smaller, being about two-thirds of an inch long, of a general reddish-brown or yellowish colour, the colour varying. The wing covers have each four raised lines. Fresh specimens are distinctly hairy, and the club at the end of the antennae has three leaves, both in the male and the female.

(3) The *Garden-chafer* (Fig. 2—*b, d,*) varies from one-fourth to one-half of an inch long, the front part of the body is of a metallic greenish colour, and the wing cases of a reddish-brown hue; the male is very hairy.

(4) A fourth species of chafer is *Cetonia aurata*, the *Green Rose-chafer* (*c*). This beetle measures two-thirds of an inch in length, and is golden green above; the wing-covers are marked with white specks and streaks.

The garden-chafer appears in June and July, and the summer-chafer about the same time, whilst the large or cockchafer usually occurs in May and June, as also does the green rose-chafer. There are slight differences in the times of flight according to weather conditions.

The grubs are thick, fleshy, and dirty-white, the tail end of the body being swollen and darker in colour; the head is large and brown, the mouth being armed with strong mandibles, which vary somewhat in each of the three species figured above; there are also three pairs of jointed legs on the front of the body. These white grubs lie with their bodies bent, and, although sluggish when taken out of the soil, are comparatively active when in it. In habits and external appearance the larvæ are very similar, but when full-grown there is a marked difference in size; the grubs of the cockchafer and the green rose-chafer reach one-and-a-half inches in length and are thicker in proportion than those of the garden-chafer and the summer-chafer, which, when full-grown, are distinctly smaller.

The grubs can be further distinguished from one another by the following microscopic characters seen in the mandibles:—In the large-chafer the mandibles have a granulated area where the light and dark parts of the jaws unite; in the summer-chafer the whole surface is very minutely granulated; in the garden-chafer there is a pale oval area with file-like ridges across it. The cockchafer grub can be further distinguished from the garden-chafer grub by the fact that the claws of its front pair of legs are longer than those of the second pair, and those of the second pair longer than those of the third pair, whereas in the grub of the garden-chafer the claws of the front pair of legs are shorter than those of the second pair, and those of the second pair shorter than those of the third.

The larva of the green rose-chafer resembles that of the cockchafer but has a large rusty spot on each side of the first segment behind the head; its feet, too, are pointed, and the body is covered with transverse rows of short hairs.

Life Histories.

The Cockchafer.—The female burrows into the earth and lays her eggs, 12 to 30 at each laying, and near one another, and up to 70 in all. After five to six weeks the larva hatches

out. No great damage is done till the second summer, when the grubs gnaw the roots of grass and agricultural plants and seedling trees, the feeding being continued during a third and a fourth summer, when the grub becomes a pupa in the soil, but the beetle does not appear above ground for egg-laying till the next May, *i.e.*, a new generation of beetles may, in our climate, be expected every four years. The cockchafer flies towards night, resting sluggishly during the day on trees.

The Summer-chafer has a similar life-history, but the grubs are destructive more to agricultural plants than to young trees. The beetles rest in the daytime and fly in the evening. They sometimes appear in thousands. There is not complete agreement as to the length of the life cycle, but very probably it can be completed in one year. The swarming of the adults lasts for only a few weeks, and may, under similar weather conditions, be expected at the same time in the next year.

The Garden-chafer.—This beetle flies in the bright sunshine, and often in great swarms. The mature beetles strip trees of their leaves, and are destructive to turnips, peas, and garden plants—*e.g.*, roses. Young fruits are also attacked. The grubs are especially harmful in grass land, the roots being bitten through. There is one generation during the year.

The Green Rose-chafer also flies in the daytime in bright summer weather, resting sluggishly during dull days. The adults are harmful to leafage and especially to flowers—*e.g.*, strawberry and other rosaceous plants, turnips, &c.,—the stamens of flowers being destroyed by the biting off of the anthers. An interesting point as compared with other beetles is that during flight the wing covers of this species are not spread, but only slightly elevated so as to allow the spread of the two hind or flying wings. The eggs are laid in the ground, in rich garden soil; the grubs have also been taken from the rotting wood of tree stumps. Pupation takes place under cover of a cocoon of earth the exterior of which is rough. Two or more years may be required to complete the life cycle.

In certain years these beetles are noticed to be more abundant than usual. These "chafer-years" are fairly regular, occurring every fifth year where the large-chafer is commonest, and every year where the garden-chafer and summer-chafer are most prevalent. It is very important to note the year in which these creatures occur in great numbers, because the next brood can be foreseen and steps taken to destroy the beetles at once. It has been noticed that these insects are somewhat local although wide-spread, certain fields being attacked time after time while neighbouring fields are quite free from infestation.

Methods of Prevention and Remedies.

Remedial measures are most effective during the beetle stage, hence the importance of having accurate data in regard to "chafer" years.

(1.) The best way of preventing the injury caused by these insects and their grubs is to destroy the beetles when they appear upon trees, &c., in the early summer. In France and Germany systematic warfare is waged against these pests, and it is only in this way, and by concerted action on the part of the farmers, that any real benefit will accrue in districts where chafer larvæ are very harmful. A single farmer on a Mayenne estate in France collected 2000 lbs. of cockchafers in the summer of 1889, and as each female may lay as many as sixty to seventy eggs the importance of such wholesale destruction is self-evident. In destroying and collecting the beetles, it should be noted which is the abundant chafer in the neighbourhood. If it be the cockchafer or the summer-chafer then it must be attacked in the daytime, especially during bright weather ; and when the weather is dull, or late in the day, if it be the garden-chafer or the green rose-chafer, for these are day fliers and often very active in the sunshine.

(2.) The beetles may be beaten down on to tarred boards from the trees and shrubs by means of long sticks, or they may be collected into sacks, and killed. This should be done, in the case of the cockchafer and summer chafer, during the day, when the beetles are very sluggish, and when they are found clinging to the lower surface of the leaves. If they are shaken on to the ground, pigs may be employed to destroy them as they are greedily devoured by these animals.

The beetles are best sought for on isolated trees and bushes, as they are said to go into woods only in bad weather. The trees should not be too vigorously shaken, or the beetles may fly away instead of falling down. Attention must be paid to the kind of beetle to be trapped on account of the different times of appearance.

(3.) Trapping the larvæ has also been resorted to with marked success. For this purpose, pieces of turf from eight to twelve inches broad and six to eight inches thick are laid, with the grass downward, on the surface of the ground. The larvæ collect beneath the turf. Heaps of turf, humus, dung, &c., may also be employed as larval traps.

(4.) When the grubs are working in the soil, gas-lime and kainit as "top dressings" have been found of benefit. On pasture land, where the attack is worst of all, a heavy dressing of gas-lime has frequently been used, and is found to kill the grass and the grubs. This seems too drastic a measure ; but it must be done thoroughly if any good is to ensue, and the grass grows strongly the following year, almost too

strongly according to one report (Ann. Rept. Zool. R.A.S.E., 1894). Dressings of kainit at the rate of 5 cwt. to the acre have been known to do much good on grass land, as has also basic slag at the same rate. The effect of all these dressings, however, depends entirely on the weather conditions. Kainit has a decidedly injurious effect upon soft larvæ; basic slag probably only acts as a stimulant to the plant.

(5.) In the case of corn and pulse crops frequent horse and side-hoeing does some little good, and in the case of garden cultivation soot and lime have been freely employed, but in the latter case hoeing and hand-picking are preferably recommended. Frequent reports are received regarding the garden-chafer on strawberry roots, but little can be done to rid the plants of this pest in the summer. Dressings of kainit, however, or a heavy dressing of soot, might be tried in the early spring.

(6.) The rook, starling, green plover, and the black-headed and common gulls should be encouraged, as they devour large numbers of white and other grubs. The two birds last-mentioned often occur far inland, and may be seen following the plough and greedily picking up any larvæ that are thrown up. The adult chafers are eaten in large numbers by owls and night-jars. Bats also eat them, and moles hunt in the ground for the grubs.

(7.) Attempts have been made in France and Germany to destroy the chafer larvæ by infecting them with fungoid diseases. Two species of fungi have been experimented with—*Botrytis tenella* and *Isaria densa*. Infection is communicable by means of living infected grubs, but not by dead ones. The results are at present not sufficiently satisfactory to warrant the extensive employment of this method of destroying the larvæ.

4, Whitehall Place, S.W.,
April, 1896.

Revised, October, 1904.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Farmers and the Income Tax.

The Board of Agriculture and Fisheries desire to give publicity to the following Memorandum, compiled under the authority of the Board of Inland Revenue, which sets out the principles upon which assessments to income tax are made in the case of persons occupying lands for the purpose of husbandry only, and the various rights of appeal and relief which exist.

By the exercise of the option (referred to in paragraph No. 4 of the Memorandum) of being dealt with according to the rules of Schedule D. of the Income Tax Acts, occupiers of land for the purpose of husbandry only who have made no profits therefrom on the average of the three years preceding the year of assessment, or whose aggregate income from every source does not exceed 160*l*. a year, are not assessed to income tax in respect of such occupation, provided, of course, that the returns they make on the form which will be supplied to them by the Surveyor of Taxes for assessment under Schedule D. are regarded as satisfactory by the Commissioners of Taxes. In such cases no appeal to the Commissioners is requisite, since no assessment is made, and no question arises involving payment and subsequent repayment of the tax.

Where assessments are made under Schedule B. the law provides ample means of obtaining relief if at the end of the year the farmer has made no profits, or if his profits have fallen short of the sum assessed, but by reason of the fact that the Commissioners of Taxes require the production of accounts before they issue a certificate for repayment, the process is necessarily somewhat troublesome to the farmer. It is for this reason that the making of a return for assessment under Schedule D. would in many cases be a simpler and more advantageous proceeding.

In any case of difficulty arising under any of the heads mentioned in the Memorandum, the Board recommend that application for advice and assistance should be at once made to the local Surveyor of Taxes.

Memorandum.

Income Tax, Schedules A. and B., on Lands used for the purposes of Husbandry.

1. Income Tax is chargeable on the annual value of lands under Schedule A. in respect of the ownership, and under Schedule B. in respect of the profits derived from the occupation. The rate of tax under Schedule A. is 1*s.* on the annual value, less certain deductions. Under Schedule B. it is now 9*d.* on one-third of the annual value, including Tithe Rent Charge, without deduction, provided that the total income does not exceed 2,000*l.* and that a claim to be charged at the lower rate of 9*d.* has been made in due time (*see* paragraph 11).

2. "Annual value" means the rack rent at which lands are worth to be let by the year, that is, the yearly rent which a tenant might reasonably be expected, taking one year with another, to pay for the lands, if the tenant undertook to pay all usual tenant's rates and taxes and if the landlord undertook to bear the cost of repairs and the other expenses necessary to maintain the property in a state to command that rent. The Finance Act of 1894 authorises an allowance from the assessment under Schedule A. of one-eighth part of the annual value of the lands (inclusive of farm-houses, and other buildings if any) as determined by the Commissioners of Taxes for the district.

3. Under the Finance Act of 1896, any owner or other person in receipt of the rent of any lands, although not the occupier thereof, has the same right of appeal under Schedule A. as if the assessment were made upon him.

4. Any person occupying lands for the purpose of husbandry only may elect to be assessed under Schedule D. on the average profits of the three preceding years instead of being assessed under Schedule B. on one-third of the annual value. The election of such person to be assessed under Schedule D. must be signified by notice in writing addressed to the Surveyor of Taxes for the district on or before the 5th of June in each year. In Scotland the time within which notice must be given to the Surveyor is extended to 5th of August.

5. Meetings of the Commissioners of Taxes are held annually between the 29th of September and the 25th of December for the purpose of hearing appeals under Schedules A. and B. and D. In England and Wales intimation of the dates of these meetings is given by notice affixed to church and chapel doors, and any person aggrieved by the assessments made upon him may appeal, on giving 10 days' notice of his intention either to the local assessor or to the District Surveyor of Taxes. In Scotland notice of intention to appeal should be sent to the Surveyor of Taxes for the district within 10 days after receipt of notice of assessment, and thereafter intimation will be given of the place and date of the meeting of the Commissioners.

6. The Commissioners also hold meetings after the expiration of the year of assessment for the purpose of hearing appeals by persons who have paid income tax under Schedule B. or D. on amounts in excess of the actual profits made in that year.

7. Persons who desire to appeal with a view to obtaining repayment on the ground of loss or diminution of profits must apply to the Surveyor of Taxes within six months from the 5th of April for information as to the time and place of meeting of the Commissioners.

8. Persons who have sustained a loss by farming operations may obtain a repayment of the tax paid under Schedule B. or D., and also, to the extent of such loss, repayment of tax paid in respect of their incomes (if any) derived from sources other than from occupation of land.

9. The printed form of account of profit and loss for the use of farmers shewn on page 5 has been provided by the Commissioners of Inland Revenue, and may be obtained on application to any Surveyor of Taxes.

10. The Commissioners of Inland Revenue have instructed their officers not to object to the admission of farming accounts made up annually from Michaelmas Day instead of from Lady Day.

11. Under the Finance Act of 1898 any person whose total income from all sources is proved not to exceed 160*l.* is exempt from the payment of Income Tax. Where the Income from all sources exceeds 160*l.*, but does not exceed 400*l.*, the person is entitled to claim an abatement of duty on 160*l.* Where the Income from all sources exceeds 400*l.*, but does not exceed 500*l.*, an abatement can be claimed of the duty on 150*l.* Where the Income from all sources exceeds 500*l.*, but does not exceed 600*l.*, relief can be claimed on 120*l.* Where the Income from

all sources exceeds 600*l.* but does not exceed 700*l.*, an abatement is allowed on 70*l.* When the Income from all sources does not exceed 2,000*l.* and any part of that Income is Earned Income, a claim may be made for reduction of the Income Tax on the Earned Income to the lower rate of 9*d.* in the pound. In order to obtain this relief a claim must be preferred at the time the Return for assessment to Income Tax is made, and must in any case be preferred before 30th September in the year for which the tax is charged. Where owners of land make any claim of exemption or abatement, the annual value of the lands assessed under Schedule A. should be taken (for the purpose of the claim) to be the amount of the assessment after deduction of the allowance of the one-eighth mentioned in Paragraph 2. For the purpose of claiming exemption or abatement, the income arising from the occupation of land is (since the passing of the Finance Act of 1896) to be taken at one-third of the annual value, including Tithe Rent Charge.

12. *Remission of Rent.*—Where temporary abatements or remissions of rent have been allowed, a reduction or repayment of duty may be claimed in respect of the amount remitted for each complete year ending on the 5th of April. The allowance may be claimed under both Schedules (A. by the landlord, B. by the tenant) on special forms of claim which will be supplied by the Surveyor of Taxes. When the remission has the effect of bringing the total income to an amount not exceeding 160*l.* the whole of the duty paid or payable will be repaid or allowed.

13. Further information on any of the points mentioned in this Memorandum may be obtained from the Surveyor of Taxes for the district, who will take steps to afford proper facilities to all persons who desire to appeal with the object of obtaining relief from or the repayment of Income Tax.

4, Whitehall Place, London, S.W.,
November, 1894.

Revised, May, 1908.

N.B.—The rate of income tax per pound is subject to yearly revision.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

[OVER.

Form of Account of Profit and Loss for the use of Farmers.

Income Tax.

No. 79D. Farmers' Appeals. Parish of ____________

County of ____________

Statement of Payments and Receipts in respect of Lands in my occupation for the purposes of Husbandry (particulars of which are entered at the back of this form) for the year ending ____________190__.

Payments :—	£ s. d.	Receipts :—	£ s. d.
*Value of *Stock* (live and dead) and *Produce* at beginning of year ...		Live Stock and Wool sold	
Live stock bought ...		Corn and Seeds sold ...	
Corn and Seeds bought for seed		Dairy Produce and Poultry sold...	
Feeding Stuffs, Oil Cake, and Manure bought ...		Other Produce, including Hay, Straw, or Roots sold	
Rent [plus Tithe, if any, paid by Tenant in addition to rent]		Labour, Stock, Implements, &c., hired out ...	
The amount of (*a*) *the Schedule A. assessment* (*i.e.*, the *net value* assessed, not the Duty paid) and (*b*) Tithe paid, if the Occupier is also the Owner		Taking in Sheep or Cattle to graze...	
Rates, Taxes [excluding Income Tax] and Insurance of Farm Stock		*Value of *Stock* (live and dead) and *Produce* at end of year	
Labour on the Farm ...		Other Receipts, viz. :—	
†Tradesmen's accounts for Goods supplied, or work done *upon the Farm* ...			
†Sundries		Value of Farm Produce used by Household ...	
£		£	

* This is the value of *Stock* and *Produce* only — not including tillages, &c.

† Disbursements or Expenses for the maintenance of the Occupier of the Lands or of his family are not to be included.

Signature ____________

Address ____________

Date ____________

Form of Declaration to be filled up and signed, when the value of the Stock at the beginning and end of the year cannot be shown in the above Account.

I solemnly and sincerely declare that the amount of live and dead stock and produce (*) upon my holding on‡ the ______day of ____________190____ did not differ materially for the purposes of this account from the average amount in hand on the corresponding day of previous years [§ except in the particulars stated below which are true to the best of my knowledge and belief].

‡Name the day to which accounts are made up. § Strike out the words in brackets if the amount is the average one.

Particulars of difference referred to above.

Description of Stock and Produce.	Increase.	Decrease.
	£	£

Signature

Leaflet No. 27.

BOARD OF AGRICULTURE AND FISHERIES.

Remission of Tithe Rentcharge.

The Board of Agriculture desire to draw the attention of owners of lands used for agricultural purposes to the statutory provision for the remission of tithe rentcharge that is made by section 8 of the Tithe Act, 1891, whereby a remission of such part of the tithe rentcharge on agricultural lands as exceeds two-thirds of the assessment of the lands under Schedule B. of the Income Tax may be obtained under the conditions laid down.

The section provides as follows:—"Where a sum is "claimed on account of tithe rentcharge issuing out of "any lands, and the County Court is satisfied that, if "the sum claimed is paid, the total amount paid on "account of the tithe rentcharge for the period of twelve "months next preceding the day on which the sum claimed "became payable, will exceed two-thirds of the annual "value of the lands as ascertained and entered in the "assessment for the purpose of Schedule B. to the Income "Tax Act, 1853, or as certified as hereinafter mentioned, the "Court shall order the remission of so much, whether the "whole or part of the sum claimed, as is equal to the "excess, and the amount so ordered to be remitted shall "not be recoverable; and if the Court is satisfied that "neither such remission, nor the liability thereto, has "been taken into account in estimating the rateable value of "the tithe rentcharge, the Court may remit such amount of "any then current rate assessed on the owner of the tithe "rentcharge as appears to the Court to be proportionate to "the amount of the remission of tithe rentcharge."

It is to be noted, however, that by sub-section 8, remission is confined to rentcharge on lands used solely for agricultural or pastoral purposes or for the growth of timber or underwood. And where lands were at the commutation the subject of a special apportionment, that is, where the tithe rentcharge in respect of a larger area was, by the desire of the landowner, specially apportioned on a smaller area, so that the smaller area bears a greater proportion of rentcharge than it would otherwise have borne, remission is not to be granted unless the Court is satisfied that the applicant would have been entitled to remission if no special apportionment had been made (section 8, sub-section 6).

The basis of any remission being the annual value for the purpose of assessment under Schedule B. of the Income Tax, it is obvious that, where there is reason to think the provision will apply, attention should first be directed to seeing that the lands are correctly assessed under Schedule B.

If the lands out of which any tithe rentcharge issues are assessed under Schedule B. with other lands, the surveyor of taxes for the parish is, on application of either owner or occupier, to divide the annual value stated in the assessment between the lands out of which the tithe rentcharge issues and the other lands, and give notice of the annual value, as so determined, to the applicant and the tithe owner ; and either of these parties, if dissatisfied, can appeal to the General Commissioners of Income Tax for the division in which the lands are assessed, who will finally determine the proper division of the annual value (section 8, sub-sections 2 and 3).

If in any case the annual value is not ascertained and entered in the assessment under Schedule B., the General Commissioners of Income Tax for the division are, on application of either owner or occupier, to ascertain the annual value for the purpose of Schedule B., and inform the applicant (section 8, sub-section 4).

On payment of 1*s*., the Commissioners of Taxes are to give a certificate of the annual value of any lands for the purposes of section 8. It is important that this certificate should be obtained, since, under Rule 32 of the Tithe Rentcharge Recovery Rules, 1891, its production at the hearing before the County Court appears to be necessary for obtaining remission.

The procedure in the County Court is available only when a tithe owner has given the Registrar of the Court notice of his intention to apply to the Court for the recovery of his tithe rentcharge. Notice of the application is served on the owner of the lands, and if he desires to obtain remission he must, at least five clear days before the hearing, give the Registrar notice of his intention to apply for a remission, and in such notice state whether more than one tithe rentcharge issues out of the lands—*e.g.*, the application may be for rectorial tithe rentcharge, and the land may also be subject to vicarial tithe rentcharge. If there is any such other rentcharge, the owner of it receives notice of the application, so that both rentcharges may be dealt with by the Court at the same hearing.

The procedure in these cases is regulated by the Tithe Rentcharge Recovery Rules, 1891, in the Appendix to which is a form of notice of intention to apply for remission.

These provisions do not apply to rentcharges under The Extraordinary Tithe Redemption Act, 1886.

The Tithe Act, 1891 (price $1\frac{1}{2}d.$), and the Rules thereunder, may be obtained of Messrs. Wyman and Sons, Ltd., Fetter Lane, London, E.C.

It may be added that where there is doubt as to the amount of tithe rentcharge charged on any lands, information can be obtained by any person on sending to the Board an Ordnance Survey Map with the lands clearly marked thereon, and on payment of a search charge, which usually amounts to two shillings. If extracts from the tithe apportionment are required there is a further small charge, the amount of which can be ascertained on application to the Board.

Copies of forms and memoranda relating to the re-apportionment and redemption of tithe rentcharges may be obtained free of charge on application to the Board.

4, Whitehall Place, S.W.,
December, 1894.

Revised, December, 1905.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of Application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Anthrax.

Anthrax is a contagious disease caused by a microbe, *Bacillus anthracis*. Human beings and all animals are liable to become infected. The disease, which shows itself suddenly, chiefly attacks cattle, pigs, and sheep, but horses are not uncommonly affected. It is often very quickly fatal, usually within forty-eight hours of illness showing itself, but in the United Kingdom it does not often spread with rapidity from animal to animal, though it may affect a number of swine at the same time if they have been fed on flesh affected with anthrax.

Symptoms.

Where an animal is attacked with anthrax its inclination is to separate itself from its companions. It stands almost immovable, with head depressed, and usually at the later stages of the disease declines every kind of food. If carefully watched, rigors, or shivers, will be seen to pass over the body ; there may be swellings (around the throat—especially in horses and pigs) which are extremely hot to the touch, the eyes have a fixed and staring look, and, if carefully examined, a small quantity of blood may sometimes be found trickling from the nose, or upon the voided fæces of the living animal. Death follows as a rule very rapidly after these symptoms are observed. Cattle are most frequently attacked by this disease.

Post-mortem appearances of the Disease.

Where an animal dies of anthrax there is generally, though not always, to be found almost directly after death a slight oozing of blood from the nostrils or some other of the external openings of the body. The carcase is swollen. The muscles may be infiltrated with blood at certain points. The lungs and glands are congested. The spleen is very much enlarged ; it is softer and darker than normal, and its substance usually resembles tar.

In most parts of this country the enlargement of the spleen in cattle is of great diagnostic importance, but in those districts where Red-water exists, enlargement of the spleen may be due to this disease and not to anthrax. In such a case, however, the spleen substance has not the same fluid, tarry, appearance. In horses and pigs, and much less frequently in cattle, the spleen may be of normal size,

although the animal has died of anthrax. The flesh is dangerous to animals and human beings.

Difficulty of recognising the Disease.

One of the greatest of the difficulties which present themselves in dealing with this disease is that the symptoms during life are not such as to lead a person who is unacquainted with anthrax to suspect the presence of the disease. Moreover, the death of the animal attacked often occurs when the owner or attendant is absent. It frequently happens that an animal which has sickened is killed, or that the carcase of an animal dead of anthrax is cut up, and the blood, which is the main source of danger, is freely spilt about the premises or on the soil. The disease is in this indirect manner spread to other animals, and in some cases the persons who have handled the carcase contract it. In every case of sudden and unaccountable death amongst stock the owner of the animal should await a skilled opinion before disposing of the carcase.

Anthrax or Suspected Anthrax to be Reported.

Every person in Great Britain having or having had in his possession or under his charge an animal (that is, a ruminating animal, pig, horse, ass, mule or dog) affected with or suspected of anthrax is required by law to give notice of the fact with all practicable speed to the Police. Failure to give such notice renders a person liable to a fine of £20, and in certain circumstances to a month's imprisonment with hard labour.

It is the duty of the Local Authority under the Diseases of Animals Acts on receiving such notice to institute inquiries, and to make proper provision for the disposal of the carcase of any animal suspected of anthrax, and for the disinfection of the premises upon which disease has existed or is suspected to have existed. The Inspector of the Local Authority is also required to give information to the Medical Officer of Health.

Precautions to be taken.

An owner of animals can do much to assist in preventing the spread of the disease amongst his stock, and it is clearly to his own interests that he should do so.

A sick animal should on no account be killed, but should be carefully isolated from all other animals. Should there be the slightest suspicion of Anthrax being present, the matter must, as before mentioned, be reported to the Police,

and in the event of such an animal dying before the arrival of the veterinary surgeon employed by the Local Authority the carcase must not be dragged along the ground, but should be allowed to remain where it is, until the examination has taken place. It is essential that *the carcase of the animal should not be cut or opened*, and steps should be taken to prevent the escape of blood or of excretions which may contain blood. Any such blood should at once be destroyed and also any drops of blood which may have escaped from the carcase to the floor of the shed or to the soil, inasmuch as every drop of blood of an animal which has died of Anthrax contains large numbers of the bacilli which cause the disease, and from these very resistent spores may form. For the purpose of destroying the bacilli contained within the infected blood a strong solution of carbolic acid should be used, and all the external openings should be plugged with hay saturated with the same solution.

Under the Anthrax Order of 1910, which came into operation on the 1st January, 1911, various provisions are required to be observed in connection with cases, or suspected cases, of Anthrax, and it is advisable therefore that stock-owners, butchers, and other persons dealing with animals should make themselves fully acquainted with these provisions, as any failure to observe them may render the offender liable to legal proceedings. The following provisions may, however, be quoted here.

Under the Order, the occupier of any premises on which there is a diseased or suspected animal or carcase must—

(i.) prevent access of animals or fowls to the diseased or suspected animal or carcase, or to any part of the premises which has been exposed to infection of disease from the animal or carcase ; and

(ii.) detain on the premises any diseased or suspected animal thereon and any other head of cattle, or sheep, or goat, or swine which has been in the same shed, stable, building, yard or field with the diseased or suspected animal or carcase.

The occupier is also required to disinfect as soon as possible with chloride of lime any place where the carcase of a diseased or suspected animal has lain or where its blood has escaped.

A diseased or suspected carcase must not be buried or destroyed otherwise than by the Local Authority, or be removed from the farm or premises upon which the animal died or was slaughtered except by the Local Authority.

Animals with which a suspected animal has been in association should be carefully watched, and isolation at once adopted in the case of the appearance of symptoms similar to those of the suspected animal. Such precautions are particularly necessary in the case of milch cows affected

or suspected of being affected. The milk of these cows may contain anthrax bacilli, and so be the means of infecting human beings. Article 11 of the Anthrax Order prescribes that the milk produced by any diseased or suspected cow or goat shall not be mixed with other milk, and that all milk affected by that Article shall forthwith be boiled or otherwise sterilised, and any utensil in which such milk is placed before being so treated shall be thoroughly cleansed with boiling water before any other milk is placed therein.

General Observations.

It is important that it should be widely known that anthrax is due solely to the introduction of the minute germs or spores of anthrax into the blood of an animal or of man. The disease may therefore be introduced by any medium capable of conveying these germs or spores. Feeding stuffs brought on to a farm, or manures made from animal substances, may be vehicles of infection. If a stream becomes contaminated, as has been found to be the case where certain industries involving the use of the hides, hair, &c., of animals are carried on, the spores may be carried to the farm by the water. The spores of anthrax develop into bacilli which find their way into the circulation of an animal through a cut or abrasion.

Where infection has once been introduced upon a farm it has frequently been continued by the ignorance or carelessness of individuals, and in some cases farms have become permanently infected with anthrax.

It is a common practice amongst owners of stock to slaughter their cattle as soon as they present symptoms of serious illness, in order that the carcase and hide may be utilized. Where, as is not uncommonly the case, the sudden illness is due to the presence of anthrax, the greatest mischief is done by such a practice. The blood of the diseased animal is distributed on the ground, or it may be on the floors of the cattle shed or upon the mangers, or is carried on the boots of the attendants to other parts of the farm or premises. The bacilli contained within the blood of a diseased animal will, when exposed to the air, multiply and produce spores which may become the means of infecting other animals at short or long intervals. Many cases have come under the notice of the Board from time to time of persons having contracted anthrax whilst engaged in slaughtering animals, or in dressing or otherwise handling the carcases of animals.

On the other hand the bacilli of anthrax die *if kept within the intact carcase* of an infected animal; no spores are formed; and experience has shown that, where the pre-

cautions recommended above have been scrupulously adhered to, the disease frequently ceases after the death of one animal on the farm.

Preventive Inoculation.

The Pasteur method of preventive inoculation has rendered great service in preserving stock on badly infected farms in various parts of the world. The method consists of injecting the animals with fixed doses of attenuated cultures of the *Bacillus anthracis.* Two injections at intervals of 12 days are performed. For the first injection a very attenuated culture is used (first vaccin), and for the second one employs a less attenuated culture (second vaccin). The immunity is established about 12–15 days after the second vaccin has been injected. In cattle it lasts about a year, and should be repeated after this period unless the ground has become purified. The great majority of cattle operated on show little more than a temporary indisposition with passing fever after the injection, which may be assumed to indicate a mild attack of anthrax. Occasionally, however, an inoculated animal may die of the disease as the result of the injection, and for this reason the animals while undergoing the process of immunization should be kept in a special paddock, or better still in sheds which can be disinfected in the event of an accident taking place. The operation should only be attempted by skilled persons, who will know the best way to prevent an accident, and guard against its consequences should it occur.

Since the operation is not altogether unattended by the possibility of loss, and since it incurs a certain amount of expense, one has to consider under what circumstances it will be worth while undertaking it. It will be obvious that on farms registering only one death annually it will hardly be called for, and that it would be folly to adopt it on clean farms.

It results from observations on several millions of cattle in various parts of the world that accidents occur in about 0·5 per cent. of the inoculated cattle taken all round, and that the operation may be expected to reduce the death rate from anthrax on infected farms to about 1 per cent. or slightly under.

If a stockowner finds that his annual losses from anthrax amount to 2 per cent. he will possibly find it profitable to have recourse to preventive inoculation.

It should be understood, however, that since the number of animals dying of anthrax in one year will vary, and since the inoculation must be repeated annually, the estimation of annual losses must be based on two or three years' casualties.

A certain degree of temporary immunity can also be almost immediately conferred by injecting a dose of anthrax serum, and the injection produces no accidents. Where animals have been exposed to the risk of what might be called gross infection (for example when a carcase has been carelessly dealt with on a pasture) it is advisable to inject them immediately with serum, and remove them to another field.

Farmers invited to assist Public Authorities.

Stockowners are, therefore, earnestly invited to co-operate with the public authorities,

(*a*) By reporting every case of sudden and unexplained illness or death, especially amongst cattle, to the Police ;

(*b*) By isolating an ailing animal, and by protecting any suspected carcase from persons or animals pending the arrival of the veterinary surgeon employed by the Local Authority ;

(*c*) By giving every facility to the officers of the public authorities in carrying out the precautionary measures enjoined by the Anthrax Order ; and

(*d*) By affording such officers every assistance in their power in tracing the origin of the outbreak.

They are further strongly recommended to give positive orders to their servants that *under no circumstances is an ailing beast to be killed by them, or its carcase opened, where the cause of sickness or death is unexplained.*

The Board have prepared a short notice (A 357/A) dealing with the principal points above set out, suitable for posting up in byres or sheds. Copies can be obtained gratis and post free on application to the Board.

4, Whitehall Place, London, S.W.,
September, 1893.

Revised, January, 1911.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 29.

BOARD OF AGRICULTURE AND FISHERIES.

Swine-Fever.

Swine-fever is a contagious and eruptive fever peculiar to swine and due to a filterable virus. By the term filterable is meant that the virus is so minute that it can pass through the pores of the closest porcelain filters. If, for example, a fluid containing the virus of swine-fever is mixed with one containing anthrax bacilli, and passed through a bacterial filter, the filtrate would contain no anthrax bacilli and would be incapable of giving anthrax to the pig when inoculated, but it would still cause swine-fever by inoculation, because the virus of that disease is not retained in the pores of the filter. The swine-fever microbe, unlike the anthrax bacillus, is too small to be seen by the highest powers of the microscope, and for this reason it may also be described as an ultramicroscopic virus. That there is a specific and infective agent, however, is not open to doubt notwithstanding the fact that it cannot be seen, for swine-fever can be produced with certainty in susceptible pigs by inoculating them with the filtered or unfiltered blood of diseased pigs.

Incubation Period.

The incubation period, that is to say the time which elapses between contact with infective material and the appearance of the first symptoms, is about five days. It is not to be concluded, however, that very distinct symptoms will always be noticed at such an early date. The first sign of infection is usually little more than a rise of temperature, which can only be ascertained by using a thermometer. In most outbreaks, the distinct signs of illness do not appear for eight or ten days, or even more, and this has led to mistaken views being held on the length of the incubative period. In some outbreaks, however, the virus is so potent that the distinct symptoms may appear much earlier, and the swine attacked may be dead in less than ten days.

Symptoms.

For the purposes of the pig owner it will be useful to describe the symptoms as much in relation to an outbreak as to the individual pig. Young swine are, as a general rule, more severely attacked than others. It seems probable that the virus of swine-fever possesses varying grades of virulence, and that in consequence, the outbreaks differ in severity. As seen in this country, the outbreaks of swine-fever might be referred to three principal classes, which tend to approach each other as the surrounding circumstances alter.

(1.)—There may be a very virulent outbreak which is characterised at the start by a very short period of illness and a large number of deaths at one time or at short intervals.

In such cases the temperature of the sick animal rises to 106°–7° Fah. The affected animals refuse food, and bury themselves in the dry litter, or, if no litter is available, they may lie up in the most isolated corners of the sty. There may or may not be a purple rash on the skin of the ears, belly and hocks, but usually there is not. Diarrhœa is generally observed. The patients gradually become unconscious and die in about a week after infection, that is to say after two or three days' illness. Outbreaks of this kind are sometimes ascribed to poisoning or other causes at the start, but swine-fever should always be suspected under the above circumstances when no definite knowledge of poisoning or other cause for the mortality is actually to hand. Usually, though not always, the virulence of this class of outbreak tones down shortly after the first onset, and a condition of affairs like the second class establishes itself; but not infrequently all the pigs of a fairly large establishment—100 or more animals—may die off in a few weeks.

(2.)—Outbreaks of medium virulence may also occur, and in such cases the disease runs a more chronic course, and the symptoms are of a less toxic nature. One or two animals die after a longer but less striking illness, and further deaths continue to take place at varying intervals. The number of animals found to be ill at one time varies according to the facilities for direct and indirect contact in the particular establishment concerned. In this class of outbreak death may occur in from ten days to three weeks after infection, but many of the affected animals may recover after a convalescence of varying duration. The symptoms begin by a rise of temperature, 105°–6° Fah. The swine go off their food, suffer from continuous diarrhœa, and become very much emaciated. They bury themselves in the litter, and can only be made to move out with difficulty. When made to move, they do so with an unsteady gait, and often show signs of pain in their joints. A noticeable symptom is great thirst, and affected animals may often be seen and heard sucking up the drainage from the floor of a wet sty. They may or may not show a purple rash on the skin of the ears, belly and hocks, and it may here be remarked that, although a purple rash in ailing pigs should always arouse suspicion of swine-fever, it is far from being a constant symptom. This kind of outbreak may ultimately assume the characters of the third class.

(3.)—In the third class of outbreak the symptoms, as a rule, are not marked. One or two deaths may occur, but frequently the only indication that anything is amiss is an appearance of unthriftiness in a number of the pigs. The absence of deaths often misleads the owner regarding the real cause of the trouble, and it cannot be too strongly insisted that general unthriftiness in a number of pigs should excite

suspicion, at least, of swine-fever. It has been mentioned that the outbreak of medium severity may ultimately assume the characters of the class under description, but many outbreaks exhibit those of the third class from the beginning. Sometimes the owner's attention is only first seriously aroused by a high mortality taking place amongst his young pigs, particularly amongst those which have just been weaned. Such a mortality should immediately arouse suspicion, and advice should be sought from the Authorities in accordance with the Swine Fever Order. It is quite common for owners to assert that their young pigs have been overlaid, when in reality they have died of swine-fever. This is the class of outbreak most difficult to deal with, since it is the hardest to locate, and frequently the pigs from the premises are sent to markets, or sold directly to other owners, in the belief that, even if they are a little unthrifty, they are none the less free from swine-fever. The affected pigs which come in this class are usually the older ones, and they may even appear quite fat and healthy looking. Pigs aged three and four months, however, may also be concerned, though usually this class of animal shows distinct signs of unthriftiness and frequently pain in the joints. In the older and apparently healthy animals a death may take place quite suddenly owing to some complication, and the owner may be misled into believing that his animal has died of poisoning, errors in feeding, or some other cause about which he has no definite information.

In all classes of outbreaks the true nature of the trouble may be masked by symptoms of pneumonia (inflammation of the lungs); some of the most fatal outbreaks are ushered in by an acute and fatal form of pneumonia, but it would also appear that pneumonia may supervene on pigs mildly affected with swine-fever and by causing deaths bring the existence of that disease to light. A number of deaths from pneumonia should always arouse suspicion, and lead to advice being sought. From what has been said above, it will be seen that the death rate from swine-fever varies in different outbreaks. From inquiries conducted by the Board during 1907 it would appear that, taking one outbreak with another, the average death rate is about 30 per cent. There is no other disease of swine in Great Britain which, as a general rule, gives rise to continued unthriftiness, and none, with the exception of swine erysipelas and pneumonia, is likely to cause such a high mortality. The experience of the Board, however, over a number of years, shows that when outbreaks of the two latter diseases are reported, the trouble not infrequently turns out to be swine-fever.

To sum up shortly, pig owners may reasonably be expected to suspect under the following circumstances: (1) When a number of animals are dying; (2) when a number of animals are sick or unthrifty; (3) when periodic deaths

are taking place, even if the other pigs appear healthy; (4) when a high mortality is noticed in sucking or newly weaned pigs, even if the older ones appear to be healthy; (5) when a number of pigs are sick or dying with symptoms of pneumonia, diarrhœa, or what may appear to be acute swine erysipelas; (6) the fact of the suspicious symptoms appearing first in pigs which have been recently purchased, or in a sow which has been to the boar, in pigs recently cut, or in those which have been off the premises to a market, and have been brought back, should always increase the suspicion, but careful inquiry into the circumstances in connection with a considerable number of outbreaks show that the fact of no new pigs having been brought on to the premises for some months does not of itself justify a definite conclusion that an outbreak of disease is not swine-fever.

Post Mortem Appearances.

The carcases of pigs which have died of swine-fever may or may not be emaciated, and purple patches may be present on the skin of the ears, belly and hocks. In the acute cases characterized by death after a short period of illness, redness of the lymphatic glands is observed, there are signs of inflammation on the mucous membrane of the intestines, while the membrane is often dotted over with innumerable red blood spots. These small hæmorrhages, however, are not peculiar to the very acute forms, and they may also be seen in the more chronic cases. In the more chronic forms one finds a diphtheritic deposit in the form of a yellowish membrane on the inner surface of the intestines. The most typical lesion is the swine-fever ulcer, which is most commonly found in the large bowel about the junction of the ileum and cæcum, but swine-fever ulcers may also be found much more rarely in the throat, on the tongue, and on the skin. In examining the intestines of sick animals which have been killed for purposes of diagnosis, it must be borne in mind that it does not follow that the disease is not swine-fever because the more typical lesions of ulceration and diphtheritic deposit are not found. The experimental inquiries conducted by the Board have shown that many animals may have a slight attack of swine-fever and recover in a little more than ten days. If cases of this description be examined in the febrile stage, nothing more may be found in the bowel than slight redness or abrasions on the folds of the mucous membrane. The most common form of ulcer is about the size of a three-penny piece. Its edges are circular, and raised above the membrane. Its centre is soft and either yellow or black in colour. Congestion of the mucous membrane of the bowel should always be looked upon with suspicion, and particularly if it is combined with inflammatory lesions in the lungs.

Virulent Material and Spread of Infection.

It may be said that the blood of pigs affected with swine-fever contains the virus of the disease, since it has been proved to be capable of infecting healthy pigs when injected under the skin. Since the blood flows through all the organs during life they must all be held to possess some degree of virulence. The intestines containing lesions are particularly virulent, and it has been shown repeatedly that swine-fever can be produced in healthy pigs with great certainty by feeding them on diseased intestines. The fæces of affected swine are also virulent. In practice the disease is spread mainly by the excretions from the bowels of affected pigs. It is highly probable that infected fæces can be carried from infected sties or premises to clean ones on the boots or clothes of attendants or castrators.

Prevention.

It might be stated at the outset that the more sanitary the condition of the premises the less difficult will it be to prevent swine-fever, once it is introduced, from spreading all through the sties; but for those who are compelled to buy pigs in the markets, or are dependent in any way on other people for their supplies, it cannot be claimed that the possession of sanitary premises is any safeguard against the introduction of the disease. After what has been stated above in relation to the virulent material and the spread of disease, it should not be necessary to do more than shortly tabulate the observances for precaution as follows :—

(1.)—Pigs which have been recently purchased, or which have been off the premises to a market and brought back again, should be kept isolated from the others for about a month, and carefully watched ; the same rule applies to sows which have been to the boar and to pigs which have recently been cut by a practising castrator.

(2.)—Sows which have survived an outbreak, that is to say those which are known to have suffered from swine-fever and recovered, should not be bred from, as there is a considerable amount of circumstantial evidence to show that they possibly infect their young.

(3.)—In the event of swine-fever, or suspicious symptoms appearing in any part of the premises, the pigs therein should, if possible, be kept rigidly isolated from the others, and have separate attendants, who should wear special boots and overalls in and about the sties. The experimental inquiries conducted by the Board show that sick and healthy pigs can be kept in close proximity without the latter becoming infected, if the sties are completely separated from each other, and the attendance is performed by separate persons. It is true, of course, that under such conditions it will be difficult at any time safely to assert that the pigs in

the other sties are not sickening for swine-fever, and that they can be sent to market without risk, but inasmuch as it is advisable on infected premises to stop breeding, and fatten off all pigs for slaughter before restocking, it will greatly tend to lessen the losses while this is in progress, if proper measures for internal isolation are taken.

(4.)—Once an infected sty has been cleared of its occupants, it should be thoroughly disinfected and left empty for about three weeks.

(5.)—If there are rats on the premises, an effort should be made to reduce their numbers by the use of one of the viruses which are harmless to pigs. This is advisable, not because rats suffer from swine-fever, but because it is possible that they may convey infected material from one sty to another.

(6.)—When affected pigs have been the subject of *post mortem* examination, care should be taken that no material from the carcase comes in contact with healthy swine, and all assistants at the operations should properly disinfect themselves.

NOTE.—Swine-fever is a disease scheduled under the Diseases of Animals Act of 1894, and the existence or suspected existence of the disease must be notified to the police (or proper authorities) in accordance with the provisions of the Swine Fever Order of 1908. Copies of this Order can be obtained free of charge on application to the Board.

4, Whitehall Place, London, S.W.,
January, 1896.
Re-written, July, 1908.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, *Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.*

A pamphlet containing 19 *leaflets dealing with Diseases and Insect Pests of Farm Animals can be obtained from the same address, price* 1*d. post free.*

Leaflet No. 30.

BOARD OF AGRICULTURE AND FISHERIES.

The Codling Moth (*Carpocapsa pomonella, L.*).

1, Caterpillar; 2, Pupa; 3, Moth. All natural size.
4, Section of Apple showing work of Caterpillar.

The codling moth is very small, but its caterpillars are, in
nost seasons, exceedingly destructive to the apple crop. They
ore into the fruit and cause it either to drop prematurely or
decay rapidly when it is stored. Sometimes apples attacked
y this insect drop off as early as the end of June, and
thers drop throughout the summer. Upon examining apples
hat have dropped, or those that show signs of decay in the
pple-house or store, it will generally be seen that there is
dark spot at the blossom end of the apple; a small hole
an also be detected here, round which there is a collection
f excreta and minute morsels of apple. If such apples
re split in half, a passage will be seen leading to the
ore, around which there is usually a mass of refuse
"frass"); and it will as a rule be discovered that the seeds,
r parts of them, have been eaten. If the caterpillar is still in
he apple, it will be found near the seeds, which appear
o be the objects of its attack. If the caterpillar has
orsaken the apple, a hole will be found on the side or
ome other part of the fruit, through which it has escaped.

Though this is called the "Codling moth," it by no means
onfines its attacks to Codlings, but was probably thus named
ecause Codlings and some of their varieties, the Keswick
Codling, for instance, are somewhat early, and, being large
pples, make a great show on the ground when they fall.
Varieties of apples having deep, open "eyes," and large dried
ufts of the calyces surrounding them, like the Codling, the
King Pippin, the Blenheim Orange, Margil, and Cox's Orange
Pippin, are more liable to be infested than varieties like the

Golden Knob, Russet, Nonpareil, and others, the "eyes" of which are more closed up. This insect also attacks pears, sometimes rather severely.

Codling moth attack is not always recognised as being due to insect agency. It frequently happens that an unusual fall of apples is said to be the "summer drop," attributable to want of vigour in the tree, or to the weather. No trouble is taken to examine the dropped fruit, and the caterpillars escape from it in due time and conceal themselves, in order to pupate and produce moths for another attack. When infested fruit is taken into store-rooms, the caterpillars creep out and get into chinks and crannies in the walls and floors, from which the moths come forth and fly to the nearest apple trees in the following spring.

Description.

The moth (Fig. 3) is from a half to not quite three-fourths of an inch across the spread wings, and is about the third of an inch in length of body. The fore wings are deep grey, with many wavy lines of a brown hue. At their extremities there are oval patches of a deep golden colour, by which this moth can be easily identified. The hinder wings are darker, having a golden tinge, and a lustrous shimmer. When the moth is at rest during the day, it is not at all a conspicuous object, sitting on the trunks, branches and leaves of apple trees, or on railings, fences, and hedges, with its wings folded in the form of a roof over its body.

The egg is flat and somewhat oval in shape, more like a scale than an egg, and about the size of a small pin's head. When first laid it is pearly white, but when about three days old a reddish ring shows on it.

The caterpillar is at first greyish-white in colour, with a shining black head, three pairs of claw feet, four pairs of sucker feet in the middle of the body, and a pair at the end. When full grown (Fig. 1), it is nearly three-quarters of an inch long, the head being brown and the body flesh-coloured or light pink.

The pupa is yellow-brown with spines on the abdominal segments; these spines aid in pushing the pupa out of the cocoon previous to the emergence of the moth.

Life History.

The moths appear about the end of May, flying from place to place and from tree to tree in the late afternoon and evening. The females place their eggs singly upon the apple when the young fruits are about half-an-inch in diameter. The eggs are laid also on leaves and it maybe on the twigs. The number of eggs laid by one female may be from 50 to 100. After a week to ten days or longer—according to the weather—the caterpillar hatches out. It enters the apple at the "eye" or calyx, feeds to begin with in this cavity, and then tunnels to the centre to the seeds, upon which it feeds, pushing back, in its progress, morsels of core, pulp and excrement, to the outside. Occasionally the caterpillar enters at other parts of

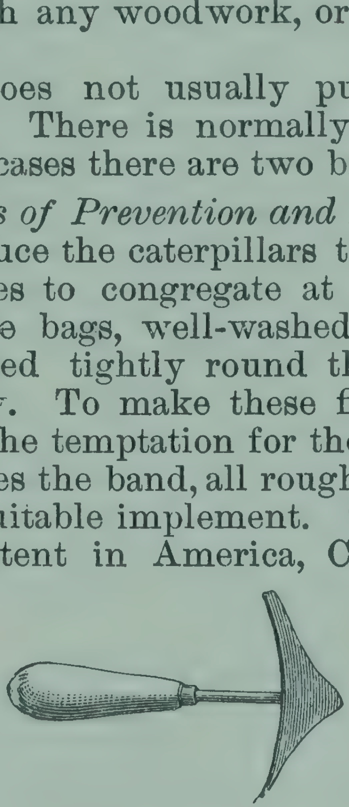
the apple, *e.g.*, at the side and, it may even be, at the stalk end; entrance may be made also where two apples touch. From about three weeks to a month may be reckoned as the average duration of the active larval stage.

After the caterpillar is full grown, and has eaten the greater part of the seeds and the flesh round the core, it bores a hole from the centre to the rind of the apple, through which it makes its exit. If the apple is on the ground, the caterpillar on leaving hides itself underneath any rubbish, or crawls away to a neighbouring stem. Should the apple be still upon the tree, the caterpillar crawls down the branches and stem till it reaches a favourable place for pupation, or lowers itself to the ground by a silken thread. Large numbers of caterpillars pass the winter on the stems, where they construct cocoons with little bits of bark knit together with silk, or composed of silk alone; they may simply get into a convenient crack or crevice in the bark, and surround themselves with a silk case, gummed over with a sticky fluid. Sometimes the larvæ conceal themselves in cracks in posts and fences, or under the bark of trees, under cover of bands on the tree or anything leaning on the tree, and even under rubbish and dead leaves, and pieces of branches and twigs near the trees. When the caterpillar is taken in the apples into the apple store, or apple house, it comes from them in due time, and hides underneath any woodwork, or in cracks in the walls or floor.

The caterpillar does not usually pupate until the first approach of spring. There is normally only one brood in a season, but in some cases there are two broods.

Methods of Prevention and Remedies.

I. In order to induce the caterpillars that are crawling up or down the apple trees to congregate at certain points, bands made of old oil-cake bags, well-washed manure bags or hay ropes, should be tied tightly round the stems close to the ground early in July. To make these fit closely to the trees, and also to remove the temptation for the caterpillar to conceal itself before it reaches the band, all rough bark must be scraped off by means of a suitable implement. This banding is practised to a large extent in America, Canada, and Tasmania.



Bark Scraper.

These traps must be examined at frequent intervals in summer and autumn, and the caterpillars in the folds of the bands destroyed.

II. "Windfalls" or "drops" must be cleared away as soon as possible, and should be disposed of at once: if not fit for

human consumption, they should be given to pigs. In orchards, sheep, pigs, and poultry are useful, as they generally eat the "drops" and caterpillars as fast as they fall. Where cider is made, the ground where apples have lain in heaps should be well gas-limed and dug deeply, and all rubbish near burned. The walls of apple-rooms and stores where the apples have appeared to be infested should be well swept and lime-washed in early spring. The floors, also, and shelves should be well scrubbed with soft soap, and fine netting fixed over windows and ventilators to prevent the moths from escaping.

III. Spraying the trees with caustic alkali wash in winter does much good, by removing the rough bark, &c., beneath which the larvæ are hibernating.

IV. Spraying with Arsenical sprays so that the young caterpillars may be poisoned before they gain entrance to the fruit. There are two sprays which can be used for this purpose:—Paris Green and Arsenate of Lead. The trees should be sprayed not later than a week after the blossom has fallen, because the calyx or eye remains open for that time and the fruitlets are upright in position; the arsenic thus lodges in the eye, and when the calyx lobes close over they keep the poison in position. Spraying after the eye is closed is of doubtful benefit, although it would account for any caterpillars which issued from eggs laid on leaves. Caterpillars in such a case have been noticed to bite leaves while on their way to a fruit. Indeed, in spraying operations in the United States a second spraying is sometimes done two weeks or more after the first.

Arsenate of Lead: Pickering's formula for arsenate of lead spray is as follows:—Arsenate of soda ("pure" or "crystallised"), 35 ounces; acetate of lead, 70 ounces; water, 100 gallons. An alternative formula is:—Arsenate of soda ("dry," "crude" or "commercial"), 20 ounces; acetate of lead, 70 ounces; water, 100 gallons. The arsenate of soda and acetate of lead should each be dissolved in half the water, when the two solutions may be mixed and the fluid is ready for use. The addition of 1 lb. of treacle helps to make the liquid stick at the outset.

For the *Paris Green spray* 1 lb. of Paris Green, 1 to 2 lb. of freshly slaked lime, and 200 gallons of water may be used.

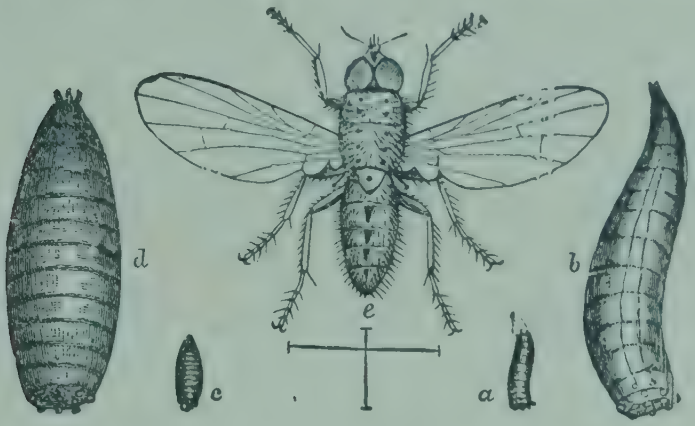
V. The blue and other tits, as also poultry, do much good in orchards by devouring the larvæ.

VI. All rubbish and dead wood should be cleared away from apple trees. It is most desirable that all barrels that have brought apples from abroad should be burned, especially those consigned to country towns, as they may contain caterpillars or pupæ from which moths would be produced. By this means fresh importations of this pest into the country would largely be prevented.

4, Whitehall Place, London, S.W.,
June, 1896.
Revised, April, 1911.

BOARD OF AGRICULTURE AND FISHERIES.

The Onion Fly (*Phorbia cepetorum* Meade).



a and *b*, Larva, natural size and magnified ; *c* and *d*, Pupa, natural size and magnified ; *e*, Fly magnified ; lines showing wing expanse and length of body.

The Onion Fly causes serious injuries to the onion crop in some seasons, and in English market gardens, and farms where onions are extensively cultivated, very many of the plants are frequently spoiled by the attacks of this fly. In cottage gardens and allotments the whole of the plants on the small onion beds of the cultivators are often ruined by successive generations of this insect. It is also a source of great trouble to onion growers in the United States, and on the Continent of Europe.

Appearance of infested Plants.

The first indications of the infestation are shown by the longest or first leaves of the onion plants becoming yellow, and afterwards whitish; if these leaves be pulled they easily come away from the stem, and gradually the other leaves become yellow and decay. The bulb will be found to be small and badly shaped, with dirty white maggots within its folds, feeding upon it, and eventually causing it to become rotten and useless.

In other cases the outer, or lower leaves of the plants are seen to be lying on the ground, still green ; while the leaves remaining upright and green feel soft and flabby.

Attacked bulbs decay, become slimy, and give off an offensive odour.

If infested plants be examined it will generally be noticed that in the case of very young plants they are nearly eaten through, just above the swelling bulbs, by the maggots

of the fly. In older plants with large bulbs maggots of all ages and sizes may be found within the bulbs.

Onion plants that become yellow and show signs of drooping should be examined for maggots just below the surface of the ground, a number of bulbs, if necessary, being cut open and examined.

Description.

The male and female flies of this species differ slightly. The male is dark grey in colour, with black bristles. The eyes are red and close together. Upon the thorax are four bright brown stripes and four rows of black bristles. The abdomen is ash-coloured, rather narrow, having triangular black spots down it which almost join each other. The legs are pitchy black.

In colour the female fly closely resembles the male, but the abdomen is dark grey, with the end more pointed than in the male ; the eyes are wider apart.

Eggs.—The eggs are white, long, and somewhat oval, and can be easily seen without a glass.

Maggot.—The maggot measures, when full grown, nearly one-third of an inch in length, and is of a dull dirty white colour. The head end of its body is sharply pointed, and the head, which is furnished with a pair of black hooks, can be extended at will ; the tail end is blunt, being cut off obliquely, and in the centre there are two brown spiracles or breathing pores ; round the margin of the flat tail end there are eight prominences.

Pupa.—The puparium or pupa case is chestnut-brown in colour, oval in shape, not so long as the maggot, and has the same tooth-like projections on the caudal end. On opening this puparium the white pupa may be seen with the wings of the future fly showing.

Life History.

It is in April and May that the flies commonly proceed to lay their eggs. From six to eight eggs are laid on an onion plant, upon the neck of the onion, and sometimes even on the lower parts of the leaves, generally just above the ground. Maggots hatch from the eggs in from five to seven days, according to the temperature and other conditions, and burrow down between the sheathing leaves into the bulb. They feed upon the contents of the cylindrical swelling, which can hardly at this stage be styled a bulb, and move on to other plants. Later, when the bulbs are larger, they are occupied by many maggots which feed within them and cause them to become rotten. The earth round the bulbs is also infested. The insect continues in the larval stage for

13 to 15 days, and sometimes longer, feeding during that time upon the onion bulbs. The full fed maggot becomes a pupa inside the brown case, generally in the soil, but sometimes in the rotten bulb, and the fly appears in from 10 to 20 days in the summer brood.

There are several generations of this insect in the year. The first has been seen as early as the 25th of April in very forward seasons, and flies have been noticed through the autumn, and as late as November. Curtis states that he saw them alive in December. Maggots may often be found early in May. The winter is passed in the puparium stage in the soil of the onion beds, or it may be in the infested harvested onions which soon decay in the store-room.

Methods of Prevention and Remedies.

1. Spraying with paraffin emulsion is a good way of preventing infestation. To make 100 gallons of emulsion the materials required will be :—

Paraffin, 5 gallons.
Soft soap, 1½ lb.
Water (95 gals.).

The soft soap should be dissolved in three gallons of boiling water, and the paraffin may then be at once added and the whole churned thoroughly by means of a hand syringe until emulsified or "creamy." The remainder of the water may then be added, and the paraffin emulsion will be ready for use. It may be applied on small plots of onions with a knapsack machine; on large breadths with a horse distributing machine. The spray should be dense and in the form of a mist. Spraying should be done early in the season, when the onion plants are quite small, and be repeated twice or thrice, especially if heavy showers fall after the process.

When the onion leaves are young and tender 10 to 15 gallons of water extra may be added. A smaller quantity of emulsion may be made by taking proportionately smaller amounts of the materials—*e.g.*, to make 10 gallons it is only necessary to divide by 10.

2. Another preventive measure is to mix sand with a little paraffin and place it at the base of the onion plants or work it into the soil.

3. Sprinkling the onions with soot may be adopted with advantage, where onions are sown broadcast.

4. Where the seed is sown in drills or shallow trenches egg-laying may be prevented by earthing-up the onion plants well over the neck.

5.—As a preventive measure it is recommended that the seed be sown in boxes under glass in February, planting the seedlings out in the open beds in April.

6. When onion plants in a field or garden are noticed to droop and wither, all such plants should be taken up and burned, or placed in quick-lime. They may be taken up by means of the little three-pronged fork used in market gardens, or some other handy tool, so that every particle of bulb and leaf is removed.

7.—Vaporite has been found beneficial in some cases.

8. A mixture of lime and soot, in the proportion of 1 bushel of soot to 2 bushels of lime, is useful. It should be very finely powdered, broadcasted over the infested plants, and lightly hoed in.

9. Nitrate of soda, applied at the rate of $1\frac{1}{2}$ to 2 cwt. per acre, should be used on infested land in order to stimulate the plants and make them grow away from the enemy.

10. Wherever it is possible, onions should not be grown again, for at least one season, on land where this crop has been infested, as the puparia remain in the ground during the winter. All pieces of bulbs should be collected on infested land and destroyed, as the larvæ occasionally pupate in the bulbs. If it be necessary to take two successive crops of onions on infested land the ground should be dug very deeply, two spits deep, and well limed, or gas-limed.

4, Whitehall Place, S.W.,
July, 1896.
Revised, June, 1910.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Foul Brood or Bee Pest.

Description.

Foul brood or Bee pest, a disease known all through the centuries, is a most terrible scourge of apiculture. It spreads so rapidly by contagion in a single season, that, unless precautions are taken, a whole neighbourhood may become affected, and the chances of successful bee-keeping therein will be seriously imperilled, if not utterly destroyed.

Two forms of foul brood have long been recognised as existing in Europe, a virulent or strong smelling, and an odourless form. A third type has recently been added ; this is called *Sour brood*, and it has usually been found associated with the strong smelling type. In the first two forms of foul brood, microscopic rod-shaped bacilli are under certaese bacilli increase by cross-division, and have, present ; thin conditions, the power of forming spores. It is important to note that bacilli are present in the earlier stages of the disease, but in the later stages, when the brood has become rotten and coffee-coloured, or has dried up to a scale, the bacilli produce spores and then perish. These spores represent the seeds of the evil ; they are a resting resistant stage tiding the bacterium over unfavourable conditions, and are capable on the return of favourable conditions of food, temperature, &c., of giving rise to the growing form of the bacillus.

The spores are endowed with wonderful vitality. Freezing, carbolic acid, thymol, salicylic acid, beta naphthol, perchloride of mercury, as well as creolin, lysol, eucalyptus and naphthalene, which evaporate at the ordinary temperature of the hive, prevent the growth of the bacilli, but have much less action on the spores. In 5 per cent. carbolic acid the spores persisted two months ; the spores also resisted the boiling temperature of water for 15 minutes. From this it will be seen how great is the difficulty in curing foul brood unless the disease is attacked in its earliest conditions.

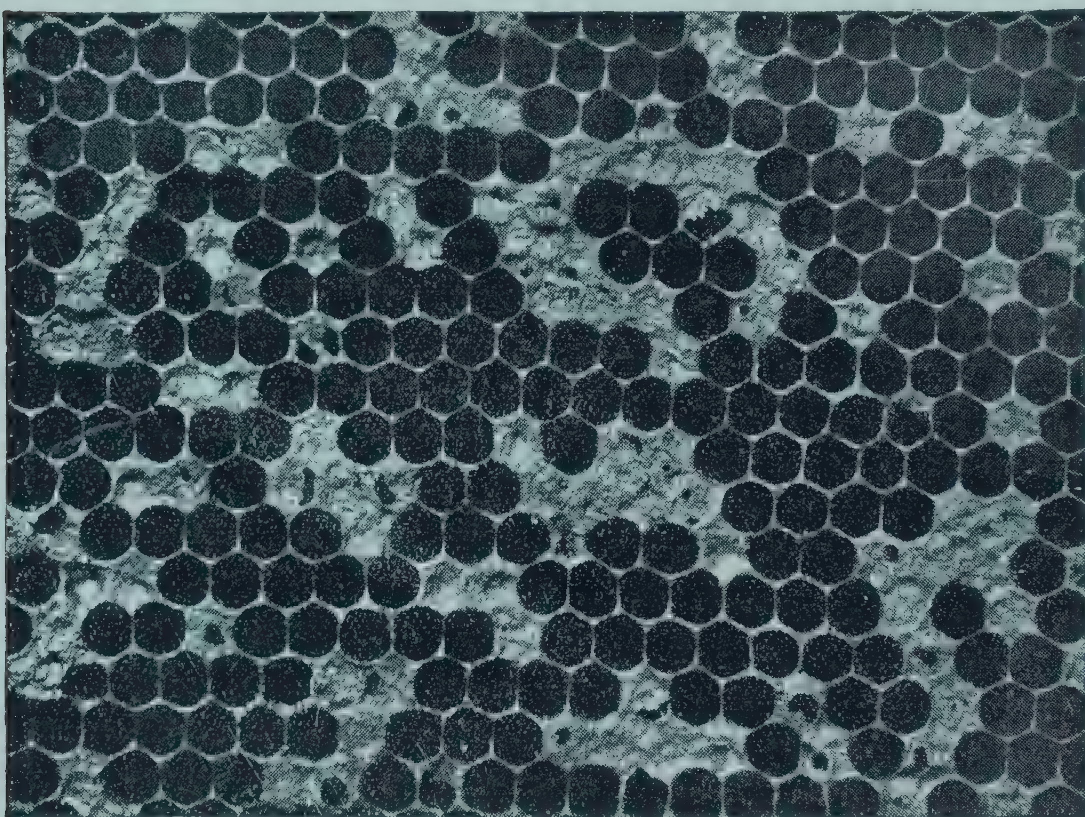
In "sour brood" a non-spore bearing organism is found.

Symptoms.

When stocks are found to be weak and are working languidly, with little desire to fly, and swarming little, foul brood may be suspected. If it is present, an examination of the combs will show some cells (many or few) containing dying or dead larvæ, and others with their covers sunken or perforated (*see illustrations*), the cells of healthy brood being usually compact, and the grubs plump and of a pearly whiteness. When healthy, the young larvæ, pearly white in colour, lie curled up in crescent shape at the bottom of the cells. On the other hand, if diseased, the symptoms vary according to the presence of the three

micro-organisms, so that the different forms of foul brood can be recognised.

When a colony is attacked by the *strong smelling* foul brood (*Bacillus alvei*, Cheshire & Cheyne), the larva begins to move unnaturally and loses its characteristic plumpness, assumes a flabby appearance and lies at the base or lower side of the cell. The colour changes to pale yellow, then to brown, and when the larva begins to decompose the mass becomes paplike or gluey, and shows slight ropiness. The difference in the decomposed larva depends on the proportion of "sour brood" associated with this form of foul brood.

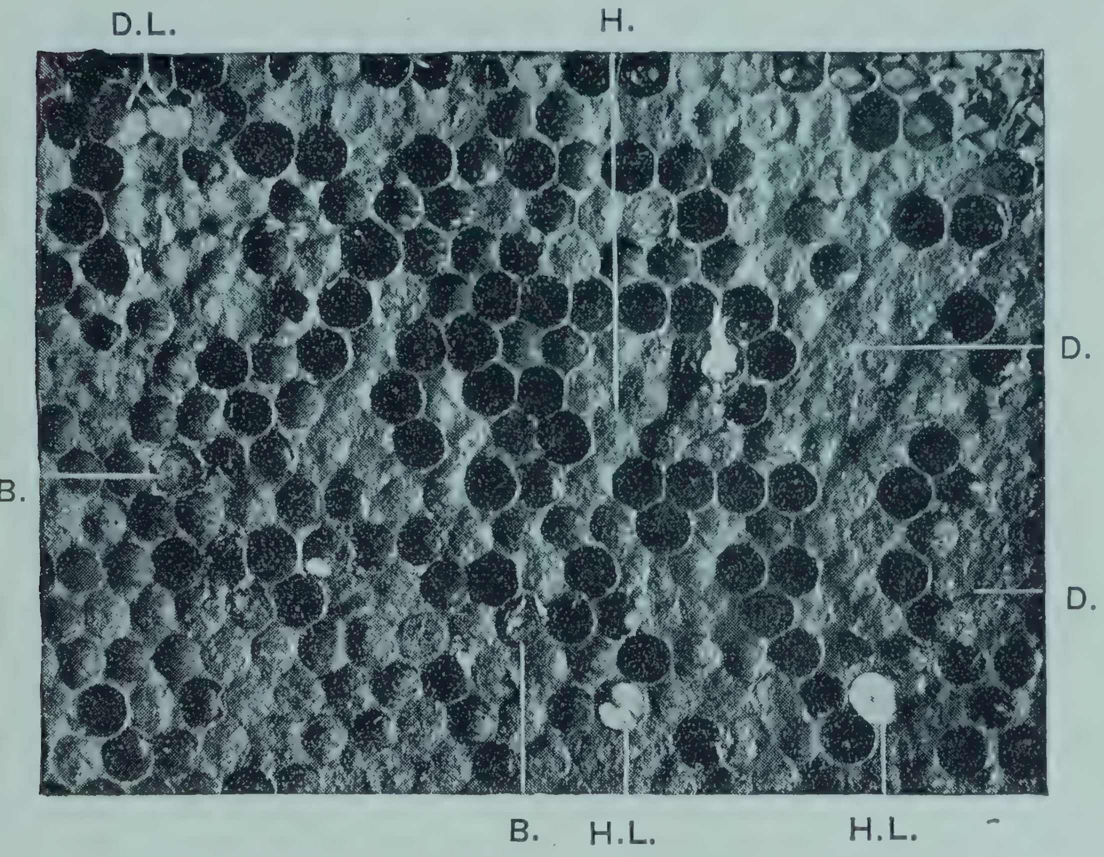


[*From a photograph lent by the Department of Agriculture and Technical Instruction for Ireland.*]

Fig. 1. Portion of a comb affected by foul brood in an advanced stage. The empty cells are those from which healthy brood has been produced, or which have been occupied by diseased larvæ, the remains of which are not discernible in the print. All the capped cells bear the appearance of being diseased. This is indicated by the sunken cappings of the cells, and the numerous perforations in the cappings.

If the former predominates the mass is paplike, and if the reverse is the case the decomposed larva is of a gluey and slightly ropy consistency. In every case a most disagreeable stench, resembling bad glue, is emitted, and in an advanced stage of the disease the foul odour may frequently be detected at a considerable distance from the hive. The foul mass in the end dries up in the cells and leaves only a *smooth* dark brown scale adhering to the lower side of the cell, and this scale is difficult to remove.

In the *odourless* foul brood (*B. Burri*, Burri ; *B. Brandenburgiensis*, Maasen ; *B. larvæ*, White) the progress of the disease is much slower, as the larvæ are usually affected at a later stage, just before or after the brood is sealed. The diseased larva lies extended on the bottom side of the cell, and soon assumes a brown colour. The decomposed mass is odourless, and on inserting a piece of stick into one of the cells, it will have adhering to it on withdrawal a ropy coffee-coloured mass, which can be drawn out in a fine thread before it breaks. The dried scale, which is dark brown and *rough*, sticks to the lower side of the cell. The cappings of the affected cells are also very much more depressed, darker, and perforated with irregular holes.



[*From a photograph lent by the Department of Agriculture and Technical Instruction for Ireland.*]

Fig. 2. Portion of comb affected by foul brood, in a less advanced stage than *Fig.* 1. The raised cappings indicate that there is a good deal of healthy brood, but the presence of diseased brood all over the comb is indicated by the sunken cappings.

H. A group of healthy cells ; other healthy cells being observable all over the comb.

D. Two groups of diseased cells, of which there are many more.

B. Healthy bees emerging from their cells.

H.L. Healthy larvæ.

D.L. Diseased larvæ. Note that these larvæ are not lying like the healthy larvæ.

In *sour brood* (*B. Güntheri*, Burri ; *Streptococcus apis*, Maasen) the larva is attacked while still curled up, and when it dies it changes to a greyish colour, then to yellow, and there is a strong acid odour resembling vinegar. The

remains are easily drawn out of the cell without rupturing the chitin covering. Sour brood is seldom found by itself, but is usually associated with the strong smelling form of foul brood.

It should be noted that "chilled brood" must not be mistaken, as it very frequently is, for foul brood. The dead larvæ of "chilled brood" turn first grey, and afterwards become nearly black, whereas in foul brood the larvæ turn at first pale yellow and then brown, except in "sour brood," when they turn from grey to yellow. The larvæ in "chilled brood" are also generally removed by the bees, which seldom attempt to carry away larvæ which have died from disease, unless disinfectants to arrest decomposition are used.

Sources of Infection.

Experience has plainly shown that with foul brood—as in all epidemic diseases—the weak, sickly, and badly nourished are specially liable to attack, and become centres of infection.

1.—A diseased stock becomes too weak to defend its stores; robbers from healthy neighbouring colonies then probably steal the honey, and in doing so carry away the seeds of disease and death, which are thus spread, until all the hives of a neighbourhood may be fatally affected. The bees do not seem to have the power to clean out the foul cells, which consequently spread infection within the hive.

2.—Another very important point is that the bee-keeper may himself be the means of spreading the pest by indiscriminately manipulating, first diseased, and then healthy hives, without taking proper precautions to disinfect himself and his appliances.

3.—Combs which have contained foul brood retain the spores. The queen lays eggs in the cells and the workers deposit their honey and pollen in them. The honey and pollen in this way become vehicles for the transport of the disease to the larvæ in the process of feeding by the nurse bees. Under no consideration should infected hives or combs be exposed to the visits of bees. Carelessness in this respect may work immense mischief to neighbouring stocks and apiaries.

Prevention and Remedies.

1.—The hives should be placed in suitable positions, and be kept clean, well ventilated, and weather-proof.

2.—In endeavouring to get rid of foul brood, efforts must be made to raise to a high standard the lowered vitality of the bees, which first enables the germs of the disease to develop. Strong stocks only, with young and prolific queens should be kept, while good wholesome food, and freedom from dampness are also important.

3.—When the bee-keeper has been in contact with diseased stocks, his clothes, appliances, and hands must be washed with carbolic soap, and other articles disinfected by spraying with a solution of one ounce Calvert's No. 5 carbolic acid in 12 ounces of water.

4.—It was formerly thought that honey was the only source of infection, and that if bees were starved until they had got rid of the honey carried by them from the diseased hive, a cure would be effected. It is now known that the starvation method often fails when it is not supplemented by disinfection of hives, etc.

5.—When the disease is discovered in a weak colony, the destruction of bees, combs, frames, and quilts, together with a thorough disinfection of the hive, is by far the best course to pursue. The spores are then destroyed, and the source of infection removed.

6.—If an affected colony be still strong, the bees may be preserved by making an artificial swarm which should then be placed in a straw skep and fed on syrup to which three grains of naphthol beta have been added to every pound of cane sugar used, the naphthol beta being dissolved in alcohol and added to the syrup while still warm.

The infected frames, combs, and quilts should then be burned, and the hive roasted, cleaned, and well painted. When the smell of the paint has disappeared, the hive will be ready for use. The bees must be confined to the skep for 48 hours, by which time all the honey they may have taken with them will have been consumed, and such of the bees as are diseased will have died.

NOTE.—It may be added that in the case of mild attacks disinfection or fumigation is sometimes resorted to, formalin being the chief agent used. In attempting such remedial measures, however, or remedial measures of the nature described above, it would be desirable, wherever such help can be procured, to seek the advice of an expert.

4, Whitehall Place, London, S.W.
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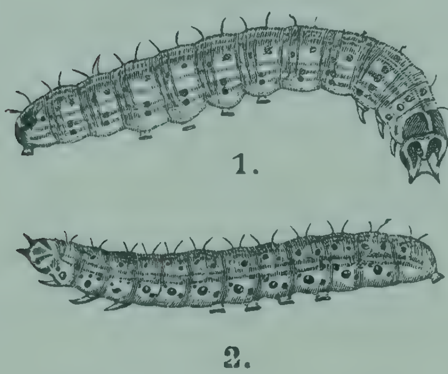
Leaflet No. 33.

BOARD OF AGRICULTURE AND FISHERIES.

Surface Caterpillars.



1\. Caterpillar of the Turnip Moth (*Agrotis segetum*).

2\. Caterpillar of the Heart and Dart Moth (*Agrotis exclamationis*).

Plants attacked.

These caterpillars cause serious injury to many crops of the farm, market-garden, and garden, and particularly to mangolds, turnips, swedes, and potatoes. They, in common with caterpillars of other species—notably that of the Great Yellow Underwing moth—are styled "surface caterpillars," because they hide beneath the surface of the soil, and usually attack most kinds of plants at, or just below, the surface, and nearly always in the night-time. The "cutworms" in the United States are similar creatures, and are so called because they cut the stems of plants asunder. Some of these American "cutworms" belong to this same genus of *Agrotis*.

Young mangold plants, and mangold plants whose growth is retarded by drought, are frequently cut through by these caterpillars below the surface of the earth, and potatoes are also attacked, the caterpillars eating into the tubers, particularly where earthing-up has not been well done. Turnips, swedes, and mangolds are often spoilt by these caterpillars, which completely clear out the insides of the roots, or so injure them that they become rotten.

Wheat and other corn plants suffer seriously from *Agrotis* caterpillars, especially wheat in mild winters. This injury is often attributed to wireworms. Grasses in pastures, particularly those with thick bulbous stems, are often eaten by

these caterpillars, which do more injury to grass land than is generally imagined. Reports have also been received of damage to the cabbage, lettuce, and carrot, to garden plants, and to flowers and seedling trees. The caterpillars pass the winter in the ground in the caterpillar state, and are adversely affected by frequently alternating frost and thaw. Mild dry springs are favourable to these pests. Dry weather prevents the caterpillar disease, which is always more prevalent in rainy seasons.

Description and Life History.

Agrotis segetum.—The male moth, rather smaller than the female and lighter in general colour, has pale grey or grey-brown forewings; its hind wings are pearly white. The antennæ are combed.

The female measures about 1½ inches in spread of wings; its forewings are dark brown; the light hind wings are clouded at their posterior margin. The antennæ are plain and threadlike.

Agrotis exclamationis.—Male paler than the female; forewings light brown, hind wings white. The antennæ are slightly dentate, or toothed.

Female red-brown in colour, the forewings dark brown, and the hind wings also brownish. The antennæ are plain and threadlike. The wing expanse is about 1½ inches and the length of the body about three-quarters of an inch.

Caterpillars.—The full-grown caterpillars are nearly 1½ inches long. One species can be distinguished from the other only by careful inspection. Close observers will note that the *Agrotis exclamationis* caterpillars (No. 2) are darker than those of *Agrotis segetum* (No. 1), the former being brownish, while the latter are grey. The most important distinction, as pointed out in Buckler's British Moths, is that in *Agrotis exclamationis* the quite black spiracles are always larger than the spots before and behind them, and that upon each of, at least, the first five segments, there is a pear-shaped blotch, rather darker than the body colour.

Life History.—The habits are the same in both species. Eggs like poppy seeds are laid at the beginning of the summer, and fastened near the ground to the leaves of cultivated plants, and of plantain, goosefoot, chickweed, and many cruciferous weeds. Caterpillars come from these in from 10 to 12 days, and begin to feed at once.

These caterpillars feed from their first appearance in summer to the spring of the next year, though probably a few of them, as stated by Mr. Barrett in his Lepidoptera of the British Isles "appear to feed up rapidly by the middle

"of August, producing moths the same autumn, and rein-"forcing the great army of wintering larvæ." During severe frosts they retire to cells in the earth. In the spring the caterpillars, being nearly full grown, feed most ravenously, finally changing, about April and May, into reddish-brown pupæ, in earthen chambers, in which state they remain for about a month.

Methods of Prevention, and Remedies.

(1.) To prevent a recurrence of the attack it is desirable to lime infested fields with ordinary lime, or gas-lime finely powdered, and to plough deeply. Turnips and swedes that are infested should be fed off early by sheep. Land after roots where there has been infestation, should be limed, ploughed deeply in autumn, again ploughed, but shallow, in spring, and not sown till March or April. It would be dangerous to sow wheat immediately after a badly infested crop of potatoes, turnips, swedes, or mangolds.

(2.) Weeds must be kept down in fields and gardens, especially cruciferous weeds, such as charlock, which afford shelter for the eggs and food for the young caterpillars.

(3.) The frequent stirring, with horse and hand hoes, of land having crops in drills, such as turnips, swedes, and mangolds, disturbs the caterpillars and kills some of them. Caterpillars or pupæ escaping death by crushing are exposed to such birds as rooks, gulls, starlings, and lapwings. The harrowing of young wheat is also of considerable advantage.

(4.) Fresh, pure, finely-powdered soot scattered on both sides of infested plants and lightly chopped in has proved to be of considerable benefit. It keeps the caterpillars off, at all events for a time, and gives the plants a chance to grow away, at least in ordinary seasons. In seasons of extreme drought this application should be repeated.

(5.) Lime mixed with soot in the proportion of 3 or 4 bushels of very finely powdered lime to 1 bushel of soot, forms a pungent compound found to be very useful in similar caterpillar-attacks, and should be sprinkled close to infested plants. The beneficial influence of soot and lime is probably due as much to its stimulating growth as to any direct effect on the larvæ.

(6.) Kainit, put on in a similar manner, near to infested plants, has a marked effect upon the caterpillars under certain climatic conditions. It is desirable to force the plants on with small repeated dressings of artificial manures, such as guano and nitrate of soda.

(7.) Potatoes should be well "earthed" where there is any fear of infestation, and the earthing should be done early in the season.

(8.) In market-gardens and gardens, and in the case of valuable crops, as cabbages, lettuces, celery, radishes, carrots, and herbs, hand-picking is advocated. The workers, provided with a lantern, and armed with a blunt knife or a pointed piece of wood, make a round of the plants at night, and dig up and collect the caterpillars. On a small scale this measure, though tedious, may be very effective.

(9.) In America there are numerous records of successful treatment by poisoning the caterpillars. This may be done by spraying clover or grass or other plants with Paris Green (1 lb. Paris Green to 50 gallons of water, the mixture to be kept well stirred) afterwards tying these sprayed plants into bundles and distributing them at intervals amongst the crop. The caterpillars eat the material so treated and are poisoned by the Paris Green. It must be remembered that Paris Green is a dangerous poison; those using it must not inhale it or allow it to get into cuts in the hands, and neither grazing animals nor poultry should have access to fields where the Paris Green treatment is being practised.

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Leaflet No. 34.

BOARD OF AGRICULTURE AND FISHERIES.

The Woolly Aphis, or Apple Root Louse.

(*Schizoneura lanigera.*)

1. Winged female, magnified; and line showing natural size. 2. Wingless viviparous female, magnified.* 3. Apple twig, covered by woolly aphides.

Distribution.

This insect is always more or less abundant in old and neglected orchards and apple plantations where the trees are unpruned and are covered with moss, lichens, &c. Unfortunately this pest is also sometimes seen in orchards recently planted. Nursery stock is frequently unwittingly sent out with families of the Woolly Aphis on the plants. It is especially on such young material that these plant-lice do so much damage. Dispersal by the agency of wind is not unimportant, but by far the most common way for the pest to be distributed is on infested nursery stock. Not only has the Woolly Aphis been carried from orchard to orchard in Britain in this way, but also from country to country, until it is now found in every part of the world where apples are grown. This Woolly Aphis, although termed also the American Blight, was originally a European insect; it is now a cosmopolitan pest.

* Figure 2 is reproduced, with permission, from Mr. G. B. Buckton's "British Aphides."

Injury caused.

Not only is the apple attacked but the pear is also sometimes affected. All varieties of apple in this country are subject to the ravages of Woolly Aphis, but perhaps the old Ribston Pippin suffers most of all. The Blenheim Orange, Cox's Orange Pippin, and Lord Suffield also suffer severely. Those trees with a soft rind are most affected. Certain experiments conducted in Victoria tend to show that with apples grafted on Majetin and Northern Spy stocks the roots are free from attack.

Infestation may be on the main trunk, on the branches, or *on the roots*; in overwhelming attack the leaves are also infested. The fact that the Woolly Aphis lives below ground on the roots should be carefully noted, as the above-ground parts, though cleared of the insect by treatment, may, unless treatment has been extended to the root-infesting individuals, receive a new infection as a result of migration from below. In America the subterranean form has been called the Apple Root Louse, and Professor Stedman of Missouri has shown that there can be migration from the trunk to the root, and from the root above-ground to the trunk.

The Woolly Aphis feeds, like all aphides, by puncturing the epidermal tissue and then draining away the sap by means of its proboscis. Not only is the tree weakened, but swellings or galls result which later on crack, an appearance being produced resembling the lesions caused by the canker-fungus. Sheltered in the canker-like cracks, the aphides are more difficult to reach by treatment.

Description and Life History.

The Woolly Aphis belongs to the genus *Schizoneura*. The arrangement of the nerves or veins on the wings is utilised to distinguish between different groups of aphides. The chief vein of the fore-wings gives off three branches; the branch furthest away from the insertion of the wing forks into two in members of the genus *Schizoneura*, and this distinguishes *Schizoneura* from another aphis that infests the apple, viz., *Aphis pomi*. Again, while *Aphis pomi* has projecting from its back two tubes known as cornicles or honey tubes, these tubes are absent in *Schizoneura*.

The Woolly Aphis may readily be recognized in an orchard by the masses of white woolly substance formed by the larvæ and females which are sheltering in the crevices of the bark. The woolly substance arises as an excretion from glands in the back of both the young and mature females. It may often be seen hanging in festoons from the trees. Parts of this "wool" get blown off and are carried by the wind, often for some little distance, and in this material young *Schizoneuræ* may be carried.

Various forms of the Woolly Aphis are found in the course of the year's cycle:—wingless females that produce live young; winged females that are also viviparous; and males without wings, which pair with wingless egg-laying females.

The wingless viviparous females are oval in shape and purplish-brown in colour. Numerous white threads pass from their backs. Their antennæ and legs are very short, and in colour are dark reddish-brown to black. Such wingless viviparous females may be found all the year round. They give rise to great numbers of young (so-called lice) which are at first of a dull yellowish colour but later become purple-brown. It is the woolly material secreted by these that gives rise to the festoons mentioned above. These lice on becoming adult produce live young in turn, and a number of such generations can be produced in the summer.

Winged females may appear from July till September. These females are dark chocolate-brown in colour; they assist in spreading the infestation. This winged generation does not appear to arise commonly. Mr. Theobald mentions having found the winged females once. During the season of 1907 a careful observer, specially on the look out for this winged generation in a district where Woolly Blight abounded, failed to find the winged females.

The wingless males and wingless egg-laying females occur towards the end of the season. They have no piercing proboscis. The egg-laying female is reddish-yellow in colour and is very small, seldom exceeding ·003 of an inch. One egg is laid and then the female dies.

The eggs are laid in crevices in the bark, near the base of the tree, and remain unhatched until the next spring; the larvæ from the eggs develop into wingless viviparous females. The number of sexual individuals seems to be small. Mr. Theobald says,* "As far as observations carried on over the past 20 years go, I can only say that this sexual brood is extremely rare in this country. Twice in 12 years it has occurred on one tree constantly kept under observation."

It is from viviparous females, hibernating under cover of crevice and moss and lichen, that the next year's generation chiefly springs.

Natural Enemies.

There are not many natural enemies that do much good in checking the increase of this pest. Possibly the woolly excretions and oily globules that surround the insect keep off the various foes which attack unprotected plant-lice.

The larvæ of Lady-birds (*Coccinellidæ*) devour them, as also do the adult Lady-birds. Larvæ of several species of Hover Flies (*Syrphidæ*) also feed upon them, but not

* Report on Economic Zoology for the year ending April 1st, 1907, page 34.

to the same extent as upon other plant-lice. Lace Wing Flies and Ichneumon Flies are seldom found attacking them. Small dipterous larvæ of the genus *Pipiza* feed on the subterranean form. Perhaps the Tits (*Paridæ*) do most good in keeping down this pest. These little birds, especially the Blue Tit, do inestimable good by devouring Woolly Aphis and other pests all the year round, and should be protected in every orchard.

Methods of Prevention and Remedy.

(1.) This blight is especially prevalent in neglected orchards, where the trees are set close together, and have their trunks and boughs covered with lichens and moss, and where rank grasses grow below. These points should all receive attention and be remedied at once. Till now, in order to remove lichens and mosses, and destroy hibernating insects, a caustic alkali wash has been recommended composed of 10 lb. of caustic soda, 10 lb. of carbonate of potash, and 100 gallons of water, to which 2 or 3 lb. of soft soap were added. Numerous records testify to the value of this wash. Recent experiments, however, conducted by Mr. Spencer Pickering at Woburn, have resulted in a more efficient Winter Wash. The directions for making 30 gallons of this soda-emulsion wash are :—

Dissolve 1½ lb. of soft soap in 1 gallon of water by heating it; add to this gradually 2 gallons of paraffin, churning up the whole with a syringe fitted with a rose-jet, until it becomes a thick creamy emulsion; stir this emulsion into 27 gallons of water in which 6 lb. of caustic soda have previously been dissolved.

In using this wash the face, hands and clothes of the workmen must be protected. *See also* Leaflet No. 70 (*Winter Washing of Fruit Trees*).

(2.) Another plan likely to do good is to whitewash the trunks of the trees. Before this is done all the rough bark must be scraped off, so that a smooth surface is made to take the wash. The best "paint" to use is one made of soft soap and lime, as follows :—1 lb. of soft soap, 1 gallon of lime, and a small quantity of size, mixed with just sufficient warm water to form a thick whitewash.

(3.) In destroying this insect during the summer and when it is on the young wood, washing to be effectual should be commenced directly the first traces of the white wool appear. Ordinary soft soap and quassia wash may be used, but paraffin emulsion (*See* Leaflet 16) has been found best for this attack.

(4.) With regard to the attack on the roots, great care should be taken to see that all young stock is clean before planting. If any traces of the "root louse" or the aerial form are seen, the trees should be returned to the nurseryman to be disinfected before being planted. All nursery stock should be fumigated with hydrocyanic-acid gas, and thus thoroughly cleared of all insect pests before planting.

Where the root form is committing havoc, the best plan is to use bisulphide of carbon. This should be injected into the soil in four places about two feet away from the trunk of the apple tree. For each injection one fluid ounce of bisulphide of carbon is sufficient for a good sized tree. It should be injected into the soil so as not to come into actual contact with a root. The liquid would harm the root, but the vapour is harmless.

This plan works very well and should invariably be followed when any white wool or rough lumps are seen on the roots of trees that seem to be in an unhealthy state. On exposing the roots the signs of Woolly Aphis can easily be noticed and the remedy should then be applied around the trees.

It must be remembered that both hydrocyanic acid gas and bisulphide of carbon are very poisonous; and that the latter substance is highly inflammable, and should not be brought near a light—the operator should not even be smoking.

(5.) Kainit hoed in round the roots has been found efficacious in Canada.

(6.) In Australia two varieties of apples are said to be proof against the action of the Woolly Aphis by reason of their bark being hard and their tissues close, thus resisting the action of the beaks of the insects. These are the Northern Spy, an American apple, and the Majetin, a Norfolk (England) variety. Apples in Australia are now always worked upon these stocks. Mr. French, Government Entomologist of Victoria, says, "Before the advent of these excellent blight-proof stocks, the Majetin and the Northern Spy, it was exceedingly difficult to find in most orchards an apple tree that was clean or in perfect health. Now, with a little care and attention, the fruit grower, as a rule, may snap his fingers at the American Blight." Mr. T. W. Kirk, Government Entomologist of New Zealand, has also given a list of varieties that are specially resistant.

Orchardists in Great Britain might profitably pay attention to this subject, which has been much neglected here. The two varieties, Northern Spy and Majetin, do not seem to be known in this country to the majority of growers and nurserymen.

4, Whitehall Place, London, S.W.,
October, 1896.
Revised, January, 1908.

BOARD OF AGRICULTURE AND FISHERIES.

The Celery Fly (*Acidia heraclei*).

1. Fly magnified. 2. Larva magnified. 3. Pupa, natural size.
Lines show natural size of Fly and Larva.

Great injury is frequently caused to celery and parsnips by the larvæ of the Celery Fly (*Acidia heraclei*, formerly known as *Tephritis onopordinis*). In mild seasons they are found injuring the leaves even in winter. In one bad attack which occurred in 1895, larvæ were found in the leaves as late as the beginning of December. Parsnips are also attacked by this fly in some seasons, and the affected roots are consequently small, much forked, and generally of a bad shape.

The larvæ make mines or passages in the leaves, and feed upon the soft juicy substance. The leaf soon contracts, blister-like patches appear, at first pale and later brown, in which larvæ can be found, and after a short period it shrivels up and is utterly useless to the plant. In the case of celery plants thus infested the stalks, or stems, that have been earthed up in order that they may become blanched, cannot grow and fill out properly. Sometimes the plant is killed or the celery is small, green, and bitter in flavour.

The larva of another fly, the Celery-stem fly (*Piophila apii*), tunnels down the blanched stalks between the folds close to the somewhat bulb-like end, evidently feeding upon the sweet juice. Its passage down the stems can be distinctly traced by rusty marks, which materially injure the appearance and the flavour of the celery, and in some cases cause it to rot.

Description.

The fly (Fig. 1) first appears in April; it is only about one-eighth of an inch in length, with a wing expanse of nearly half an inch. It is tawny brown in colour, or, as Meigen terms it, "honey yellow," with the under

part of the body lighter coloured. The wings are transparent and iridescent, with oblique lines of brownish or rusty spots running through them, and the poisers are of a dark yellow hue. The eyes are deep green in colour; and the six legs are dark yellow and covered with black hairs. When the fly is at rest upon the plants its wings are folded in an upright direction. The female fly is larger than the male.

The larva (Fig. 2) is white to very light green, without legs, and the dark line of the alimentary canal is visible along the back. The body is thick, pointed at the head and squared off at the tail end, upon which there are black tubercles.

The puparium (Fig. 3) is oval, of a light yellow colour, barrel-shaped, much wrinkled, and about one-eighth of an inch long.

Life History.

The fly places its eggs singly upon the upper sides of the celery and parsnip leaves. Many eggs are laid by one female. The eggs are hatched in about six days, and the larvæ from them at once bury themselves in the leaf tissues and form mines within them. In about 14 days the larva changes to a pupa inside a pupa-case or puparium, either remaining in the leaf or falling to the ground. The fly hatches out in a few days, and there are several broods or generations in the course of the summer. The last generation remain in the puparium stage in the earth and also on pieces of leaf and stalk throughout the winter.

Preventive and Remedial Measures.

1.—When the celery crop has been taken from the trenches the earth should be carefully levelled and well dug, and the upper surface buried deeply to prevent the flies from coming up from the puparia that are found in the soil. This should also be done in the case of infested parsnips.

2.—If infestation is severe, a number of puparia will remain in the soil. These puparia should be destroyed either by skimming the surface layers and burning, or else by a dressing of gas-lime.

3.—Directly the celery or the parsnips have been dug, every particle of foliage and stem should be collected and burned. If it is merely put in bulk upon compost heaps, or mixens, not in active fermentation, it is most probable that the puparia will be carried out with manure for celery or parsnips, or other crops grown near, and the flies will issue in due course. In cases where the foliage and stem cannot be conveniently burned they should be deeply buried. The pest will not be stamped out unless celery and parsnip growers are most particular in destroying the remains of infested plants.

4.—Thistles also should be kept down. Curtis says that the fly infests the "Cotton Thistle," *Onopordon Acanthium*. Meigen and Macquart both say that it infests thistles in France and Germany.

5.—It is desirable to force rapid leaf growth where there is a bad attack. Nitrate of soda mixed with a little agricultural salt, and frequent and heavy watering, will effect this.

6.—Finely-powdered soot or lime scattered over the plants while the dew is on them might prevent the flies from laying eggs upon the leaves. A mixture of finely-powdered soot and lime in the proportion of one bushel of lime to three bushels of soot has been found efficacious, if put on when the leaves are damp from dew or rain.

7.—Spraying the plants with various preparations has proved beneficial. A mixture of paraffin and soft soap and water, at the rate of a quart of paraffin and half a pound of soft soap to 10 gallons of water, has been found effective. The paraffin and soft soap must be thoroughly incorporated in a small quantity of hot water before being mixed with the cold water. A spray made with a pint of carbolic acid and half a pound of soft soap to 10 gallons of water has also been tried with advantage. Tobacco wash is also used. These preparations should be sprayed lightly on the plants by means of a knapsack machine, and will prevent the flies from laying eggs upon them. It will be necessary to spray twice or more during the season. It is especially upon young plants that this treatment is beneficial.

8.—Theobald advises the protection of the seedlings with muslin or canvas covers and the capture of the flies in bright weather, by sweeping the rows of plants with an insect net.

4, Whitehall Place, London, S.W.,
March, 1897.
Revised, March, 1912.

Copies of this Leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 36.

BOARD OF AGRICULTURE AND FISHERIES.

Cultivation of Osiers.

The term Osier is popularly used as comprehending all trees or shrubs of the genus *Salix* which are cultivated as a crop to be converted by the basket-maker and similar craftsmen into various articles which are known as "wicker work." The genus *Salix* includes willows, sallows, and osiers. Most of the kinds grown for a crop in the Fen district are, it is stated, really willows, and not osiers ; that is to say, if they were allowed to grow to their full height they would attain the dimensions of trees.

Osiers are grown in enclosed plantations, which are locally known as holts. The produce of the osier holt is known commercially as "rods."

Soil and Situation.

The most suitable soil for the growth of osiers is a deep, rich, moist, alluvial soil. Any good clay may be planted if sufficiently moist. Peat, moor, and hot gravels, are absolutely unsuitable. Though water is requisite, a holt will not thrive in stagnant water.

In the village of Mawdesley (Lancs.) willows are grown under similar conditions to ordinary farm crops, and the rods have acquired a reputation for strength and durability. It is to the comparatively dry method of culture that the special toughness of the rods is attributed.

In the Fen district osiers are chiefly grown along water-courses, on land which is subject to flooding. A variety of circumstances contribute, perhaps, to this situation being almost universally selected. It is not merely that this is the natural *habitat* of the genus, and that the soil is suitable, but the convenience of having close at hand water carriage for a bulky and heavy crop, which must be for the most part removed in a green state, has no doubt tended to restrict the growth of osiers almost entirely to the neighbourhood of rivers. An additional reason for the selection of such sites is, that the periodical winter floods bring down from the uplands a considerable quantity of soil which acts as a fertiliser. Floods, however, are occasionally the cause of considerable injury to the holts. An ice flood cuts the rods and seriously damages them. Sheet ice settling down on the holt will entirely destroy a crop, as in 1893; and a spring flood which covers the young shoots will kill them; but freshets, which disappear quickly and which do not rise above the tops of the rods, do no harm.

Preparing the Land.

The site of a holt having been selected, the land should be thoroughly cleaned during the summer before planting, and it may be worth while to give it a complete summer fallow. Before the winter sets in it should be thoroughly stirred, either by digging or ploughing, to a depth of 14 or 16 inches.

If the soil is not naturally rich, it should be manured. On a large plantation in the Mawdesley district the manure which finds most favour is a Manchester production prepared principally from night soil. One ton per acre is usually given, this amount being repeated in spring, with an additional dressing a month or two later if the soil is poor.

Soot is a good preparation for the crop on account of its insecticidal properties.

Planting and After Management.

Planting should be done in February or March. Sets cut from wood of two years' growth are preferred, but a good many one-year sets are used. They should be 16 or 18 inches long, and about 10 to 12 inches of the set should be in the ground. (Still shorter sets of 14 inches are often planted.) About 19,000 to 20,000 sets are required per acre, the distance apart being about 18 inches. The cuttings may cost 10*s.* per 1,000, the total cost of preparing and planting being variously estimated at from 14*l.* to 23*l.* per acre.

During the spring and early summer the spaces between the rows must be kept clean by hoeing and forking, but the latter must be done with caution where the roots are near the surface. The cleaning should be completed before the middle of June, or at latest by mid-July, or the osiers will be injured. Where Bindweed is prevalent it is liable to ruin the crop, and a final June cleaning would not be sufficient. The cost of cleaning is variously estimated at from 1*l.* to 3*l.* per acre per annum for the first two years. After that time the expense of cleaning is much less, as the dense and rapid growth of the osiers stifles and smothers all other vegetation. It may be mentioned in passing that the young shoots from an established stock will sometimes make a growth of as much as 18 inches in the course of a single week, but such a growth is probably rare ; during the present season, however, it was attained in the Fens.

Under the most favourable circumstances the newly-planted holt will be at maturity after a period of three years, but as a general rule four or five years must elapse before its full development. Exceptionally, quite a fair crop is produced in two years, but this is rare.

A holt properly planted, kept clean, regularly filled up, and well managed will last from 10 to 15 years, the duration depending upon the sorts planted and upon various circumstances which affect the several kinds of osiers in different ways.

Varieties of Osiers Grown.

The willows and osiers usually grown in the Fen district are known locally by names indicative either of some characteristic of the tree or of the country from which it has come. The favourite sorts are :—

Glibskins.—In some situations this kind is particularly liable to "scab"; it is now seldom planted.

Black Mauls.—Small, but hard and tough, and consequently valuable.

Green Sucklings.—A heavy cropper, but not liked by the basket-maker; this sort is of poor quality.

Welsh Osier.—This has a very bitter rind, which is disagreeable to all animals; it is planted on the outsides of holts.

Black Hollanders; Mottled Spaniards: these kinds are now seldom planted.

Cane Osiers; and Dutch Red: the latter being a small sort used only by market gardeners for binding purposes.

Most of these have been botanically determined at the Royal Gardens, Kew.* Cuttings of a dozen kinds were obtained from a practical osier grower in Hunts; and it was found that *Glibskins*, *Black Mauls*, *Green Sucklings*, and *Black Hollanders* were all varieties of *Salix triandra*. The *Welsh Osier* is known botanically as *Salix purpurea*, the *Mottled Spaniard* as *S. decipiens*, and the *Cane Osier* as *S. viminalis.*

A certain proportion of the coarse-growing osiers may be grown, as the basket-makers require some strong stout rods for uprights; where they are not grown their place is supplied by leaving a portion of the holt to grow for two or three years.

Cutting the Rods.

The osiers attain to their full growth by the middle of September. They will make an average growth of 8 or 9 feet, and, occasionally, as much as 13 feet, in a single season.

Cutting the rods commences with the new year, if the holts are accessible. Sometimes, however, floods or other circumstances prevent the early cutting, and the process has to be postponed. It is, however, considered very desirable to cut before the sap rises, as the stocks bleed, and the new growth is less vigorous, if the sap has risen before cutting. The rods are cut with a sharp hook, somewhat like a strong reaping hook; a clean cut, without splitting the rod, is essentially necessary. It is also very important that the rods should be cut so low down that only a short spur of the old wood is left; otherwise numerous buds are left, the result being many weak shoots in the next year in place of a

* See *Kew Bulletin*, 1896, p. 143.

few vigorous ones. As the rods are cut, they are tied up by willow bands into bundles or "bunches." Each bunch has a girth of 45 inches (an English ell) at a distance of 1 foot from the butt end of the bunch. The "ell band" is secured in its place by attachment to another band, called the "breech band," round the butt end. A third band is placed higher up. An average crop will be about 150 bunches per acre, and a heavy crop will reach to 250. A green marketing bunch will weigh 6 stones.

Green rods are fresh cut and unpeeled.

Brown rods are those which have been left to dry in their skins.

White rods are those which have had the bark removed or peeled.

Buff rods are produced by boiling green or brown rods and then peeling them; but the colour thus produced is imitated by dyeing.

Peeling and Sorting the Rods.

When the rods are to be peeled, they are placed with their butt ends in water, where they remain until the rise of sap makes the rind separate easily from the stick. (Sometimes, owing to carelessness, cut rods become dry owing to exposure to the air, and in that case they are put in a heap, watered, covered up, and sweated, or "couched" as it is called.) If the rods get too advanced in growth before peeling, the difficulty of peeling is increased, and the rods are damaged.

The work of peeling begins as soon as any of the rods are fit. It is chiefly done by women, who draw the rods through a simple instrument termed a "break" or "cleave." This divides the bark into strips, which are removed by hand. The children of the peelers sometimes assist in this latter operation.

As the rods are peeled, they are sorted into three grades, "large," "Middlesboro," and "small" rods, according to their size and length. They are then exposed to the air for a short time on racks, or reared against hedges or walls. When dry they are tied up in bunches of the same dimensions as before, and stored away in sheds.

"*Skeining*" *Rods.*

Rods which are adapted for the purpose, and which are, in consequence, most valuable, are subjected to another process known as "skeining." This is the longitudinal division of the rod by splitting it into equal parts. The thin end of the rod is nicked with a knife, dividing the circle into three sectors. A triple wedge is then inserted, and the rod is drawn rapidly through the hand. The split rods are then drawn twice under a knife fixed to a gauge to remove the outer ring and inner angle, and the rod is reduced to a flat thin strip of equal thickness. These

"skeins" are used for weaving sieve and riddle bottoms, and for making basket handles and similar articles. Green rods are "skeined" by the same process, for making eel grigs, &c.

Hitherto the ordinary practice of most growers has been to sell the rods, when cut, to persons who peel, sort, and store them, but under certain conditions growers may find it much more profitable to prepare the rods themselves.

The information given above relates to the cultivation of osiers in the Fen districts, but the Board think it may be useful in addition to summarise an account of an osier bed situated on an island in the River Thames opposite Isleworth.*

A River Thames Osier Bed.

The area of the osier bed is about $6\frac{1}{2}$ acres, and, being in the tidal portion of the river, it is flooded during high tides. The soil is a rich stiff loam, being the accumulation of alluvial deposits brought down by the river. The common osier (*Salix viminalis*) is grown to produce rods fit for making small baskets. The area has been an osier bed for a very long time, and some of the old stools are about 2 ft. in girth, perfectly sound and yielding as good rods as ever. On one of the old stools nearly seventy-five shoots were counted. The stools stand roughly about 18 inches apart, so that there are 19,000 stools per acre.

Planting is done soon after the crop is harvested, *i.e.*, about the middle of February. The best one-year-old shoots are used, and are merely stuck about 9 inches deep into the ground. Weeding is done about the end of May.

The harvesting of the crop is commenced in the latter part of December or early in January, and is completed in about five weeks. Care is taken to cut the rods clean close to the edge of the stool, and they are then sorted into sizes and stacked until Easter, when they are peeled.

The bulk of the crop is used for making small baskets for use on the Syon Hill Farm.

The crop is sorted into the following classes, which are stated to be those now used on the London market: (1) rods over 11 feet in length; (2) rods 9–11 feet; (3) rods 7–9 feet; (4) rods 5–7 feet; and (5) rods below 5 feet in length. The first four classes are peeled by means of the "break," but the last class is not peeled.

All the operations are carried out by piecework:—

Cutting.—The cost of cutting is 6*s.* per score of bolts of various sizes. These are generally about 20 inches in circumference near the butt end.

Sorting.—The sorting costs 5*s.* per score of bolts of 40 inches in circumference.

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* See the account by Mr. B. V. Ramaiengar in the *Quarterly Journal of Forestry*, April, 1907.

Peeling.—The cost of peeling varies according to the class of bolts, but averages about 10*d.* per bolt.

Basket-making.—It costs $7\frac{1}{2}d.$ to make a bushel-size basket having alternate bands of peeled and unpeeled rods.

Planting.—The cost of planting is 2*s.* 6*d.* per 1,000 cuttings.

Weeding.—This costs 5*l.* annually for the whole area.

Yield.—The yield is 750 bolts of green unpeeled rods of 40 inches girth near the butt end, *i.e.*, 115 bolts per acre. These 750 bolts of unpeeled rods yield 60 bolts of peeled rods of the first size, 500 bolts of peeled rods of other sizes, and 100 bolts of unpeeled rods of the "small" size. With these 600 bolts, 5,000 baskets are made. The average weight of a bolt of peeled rods (in August) is 56 lb. and of a bolt of "small" rods 28 lb., the total yield being at the rate of 2 tons 7 cwts. per acre.

Revenue.—The accounts for 1905 showed a net revenue of 15*l.* 7*s.* 8*d.* per acre.

NOTE.—It would appear that there is room for a considerable increase in area devoted to the cultivation of osiers, as basket makers are forced to purchase foreign material, even for use in districts well adapted for the production of osiers.

Further information relating to the cultivation of osiers will be found in articles by Mr. W. J. Cochrane in the *Transactions of the Highland and Agricultural Society of Scotland* (5th Series, Vol. V., 1893), and by Mr. E. J. Baillie in the *Journal of the Royal Agricultural Society of England* (3rd Series, Vol. V., 1894); and attention may be directed to their remarks as to the suitability of sewage farms for the growth of osiers. A note on the cultivation of osiers in Holland and Belgium appeared in the Board's *Journal* for April, 1907, p. 47; an account of their cultivation on the Atlantic seaboard of the island of Harris appeared in the *Transactions of the Royal Scottish Arboricultural Society* for January, 1908; while an article on "The Cricket-Bat Willow" was published in the *Kew Bulletin*, No. 8, 1907.

A special inquiry into the subject of osier cultivation was undertaken in 1893 by one of the Board's Inspectors, and this leaflet was originally based on his report, but has since been considerably revised.

4, Whitehall Place, London, S.W.
May, 1893.

Revised, October, 1908.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of Application so addressed need not be stamped.

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Leaflet No. 37.

BOARD OF AGRICULTURE AND FISHERIES.

Rabies.

The Board of Agriculture consider it desirable to give further publicity to the following paragraphs on the subject of Rabies, which have been extracted from the report of the Departmental Committee appointed by the Board to inquire into and report upon the working of the laws relating to Dogs.

The Committee report as follows :—

Rabies.

We have concluded from the terms of our reference and from the composition of the Committee that it was not intended that we should re-open the pathological question of the origin and nature of rabies, and throughout our inquiry we have acted on the assumption that the conclusion of the Select Committee of the House of Lords of 1887 was correct. That Committee reported "that it is practically "proved that subcutaneous inoculation with the virus of "rabies is the only ascertained means of imparting the "disease, and in order to check it every effort should be "made to prevent the dissemination of that infective "substance." We have, therefore, limited our inquiry to the examination of the efficacy of the existing system of dealing with rabies, and to the consideration of the means which may be taken by legislation or administration to make that system more effective.

Prior to the passing of the Dogs Act of 1871 (34 & 35 Vict. c. 56) the Acts of Parliament which dealt with the muzzling of dogs, and the disposal of rabid dogs, were mainly of a local character.

The Act of 1871, which is still in force, and applies to the United Kingdom, empowers the police to seize savage or dangerous dogs not under proper control, and authorises certain local authorities to impose restrictions on dogs not under proper control where a rabid or suspected dog is found within their respective districts.

In 1886 the Privy Council were empowered by the Contagious Diseases (Animals) Act of that year (49 & 50 Vict. c. 32 s. 8) to extend the definition of animals for the purposes of the Contagious Diseases (Animals) Acts, so that those Acts should comprise for all or any of the purposes of those Acts any kind of four-footed beasts, in addition to the animals mentioned therein. On the 16th September of that year the Privy Council issued the Rabies Order of 1886. A copy of this Order, which came into force on the 1st October 1886, is printed in the Appendix to the Committee's report, but it may be stated shortly that notification of rabies was made compulsory, that the necessary powers were conferred upon the local authorities to deal with cases of disease thus notified, and that those authorities were empowered to make regulations with regard to muzzling, the keeping of dogs under proper control, the seizure and disposal of stray or unmuzzled dogs, and the prohibition or regulation of dog shows.

This Order was re-enacted, with certain amendments of the powers conferred upon local authorities, by the Rabies Order of 1887, which took effect as from the 28th February 1887.

Local Authorities availed themselves of the powers conferred by these Orders, but not to any considerable extent.

In 1889 the Board of Agriculture was formed, and under the Board of Agriculture Act, 1889 (52 & 53 Vict. c. 30), the powers of the Privy Council under the Contagious Diseases (Animals) Acts were transferred to the new Department. The Board were at the same time empowered to make orders for the muzzling of dogs and the seizure, detention, and disposal of stray and unmuzzled dogs.

On the 9th July 1889 the Privy Council passed an Order which came into force on the 1st August, providing for the muzzling of dogs in the City of London and the Metropolitan Police districts, and later in the year this Order was repeated by the Board of Agriculture, and extended so as to comprise the counties of Cheshire, Lancashire, and the West Riding, and the whole of the counties of Essex, Hertford, Kent, London, Middlesex, and Surrey, with the boroughs locally situated therein. The new Order took effect from the 1st January 1890.

From time to time the Board made Orders extending the Rabies (Muzzling of Dogs) Order of 1889 to other districts, or, where the position with regard to disease had improved, granting an exemption from muzzling in favour of dogs wearing a collar. In 1892, however, the amount of rabies in the country had so considerably diminished that the Board passed Orders, as from the 1st November 1892, revoking all

former Orders, and again empowering local authorities to make regulations as to muzzling and at the same time imposing upon them the specific duty of seizing and disposing of all stray dogs found within their respective districts.

In 1894 the Contagious Diseases (Animals) Acts were consolidated under the title of the Diseases of Animals Act, 1894 (57 & 58 Vict. c. 57), and the Board of Agriculture re-issued the Rabies Order of 1892, with certain modifications, under the title of the Rabies Order of 1895.

It will be seen from the foregoing statement that recent experience with regard to rabies divided itself into two distinct periods. From 1889 to 1892 muzzling regulations were imposed by a central authority over wide areas, embracing the districts of numerous local authorities, whilst in the period from 1893 to the present time it has been practically left to local authorities to decide, each for themselves, whether or not muzzling regulations should be imposed.

A comparison of the two systems is of the first importance in the consideration of the lines upon which the law is hereafter to be administered, and the facts which such a comparison elicit are fortunately so striking as to leave no room for doubt as to the relative values of local and central control in this matter.

In the four years during which muzzling regulations made by the Board of Agriculture were in force the number of cases of rabies in dogs reported was as follows :—

In 1889	there were	312	cases.
„ 1890	„	129	„
„ 1891	„	79	„
„ 1892	„	38	„

Since the issue of the Rabies Order of 1892, and the practical relegation to local authorities of the duty of making muzzling orders, the disease has shown a very marked increase ; the number of cases reported has been as follows :—

In 1893	there were	93	cases.
„ 1894	„	248	„
„ 1895	„	672	„

In 1895, owing to the great prevalence of disease, muzzling regulations were more generally enforced by local authorities, and in 1896 there were in the 49 weeks ended the 5th December 422 cases reported as compared with 649 in the corresponding period in the preceding year.

Rabies in London has followed very much the same course as in the case of the country as a whole.

Muzzling regulaticns were in force in the county of London from August 1889 to October 1892. They were then withdrawn, but they were reimposed in February 1896. The number of reported cases was as follows :—

In 1889	there were	123	cases.
,, 1890	,,	32	,,
,, 1891	,,	13	,,
,, 1892	,,	3	,,
,, 1893	,,	8	,,
,, 1894	,,	12	,,
,, 1895	,,	46	,,

Since the re-imposition of the muzzle in February 1896, the number of cases for each month, up to and including November, has been February, 22 ; March, 21 ; April, 10 ; May, 11 ; June, 11 ; July, 11 ; August, 2 ; September, 1 ; October, 4 ; and November, 2.

It will be seen that the general results of the imposition of a muzzling order in London correspond with the results derived from the whole country, and we have reason to believe that the figures for every other area over which muzzling has been applied would teach the same lessons.

The number of deaths from hydrophobia in England and Wales in the same period presents similar features, and was as follows :—

In 1889	there were	30	deaths registered.
,, 1890	,,	8	,,
,, 1891	,,	7	,,
,, 1892	,,	6	,,
,, 1893	,,	4	,,
,, 1894	,,	13	,,
,, 1895	,,	20	,,

These statistics appear to us to fully confirm the views expressed in their evidence by the Chief Veterinary Officer and the Principal of the Animals Division of the Board of Agriculture, and to justify the conclusion, at which we have arrived, that muzzling is not only an efficient, but the only means which is now practicable, for the extermination of rabies, but that the powers of muzzling as exercised since 1892 by local authorities, acting in complete independence of one another, are inadequate to eradicate rabies, and only result in temporary and local checks to its spread. As the Principal of the Animals Division of the Board of Agriculture stated in his evidence : "The disease will continue to "rise and fall in waves unless it is altogether eradicated," and "so long as the public look upon it with indifference "the disease will rise : so soon as they begin to be at all "alarmed, then the necessary steps will be taken to decrease "it."

The futility of the system which has been in operation since 1892 largely accounts, in our opinion, for its unpopularity. It produces the maximum of local irritation with the minimum of general and permanent good. Surrey naturally grumbles at the retention of a muzzling order within its limits, when Berkshire, co-terminous with it, is permitting its dogs to go unmuzzled, even although an outbreak of rabies may have occurred much closer to the Berkshire boundary than are a very large number of the dogs required by Surrey to be muzzled.

The state of things in Lancashire and the West Riding of Yorkshire is still more striking. In each of these counties the county area is studded with borough islands, Lancashire being governed in this matter by no fewer than 34 separate local authorities, and the West Riding by 16. Each one of these separate local authorities imposes or remits muzzling orders according to its own pleasure and convenience, often without regard to the action of neighbouring authorities or to the general weal of any large tract of country.

On the other hand, the Board of Agriculture, under the law as it stands, have the power and the machinery necessary to enforce muzzling in a general and systematic way, and experience has shown that by the exercise of the functions vested in them as a central authority, the suppression of cattle plague, foot-and-mouth disease, and pleuro-pneumonia has been obtained.

We think, therefore, that the time has come and that the circumstances are opportune for the Board of Agriculture to make a determined and systematic attempt to stamp out rabies.

This will not, in our opinion, involve universal muzzling, inasmuch as there are districts where rabies has never appeared.

What is necessary is that the Board of Agriculture should have regard to the country as a whole and should impose muzzling over considerable areas, irrespective of the boundaries of boroughs and counties, that the Board should impose it, in fact, where it is really required and leave the rest of the country free. We believe that much of the feeling against the present capricious and ineffective system of partial and uncertain muzzling will not show itself against the operation of a centralised system carried out on well-considered lines and effectively producing the result which all desire to see achieved, viz., the suppression of rabies.

We confidently hope that our proposal will achieve this result, and that it will then become unnecessary again to resort to a measure, the inconvenience of which we fully recognise, but which we now recommend as the one practical means to a much desired end.

The complete report [C. 8320.] of the Departmental Committee on Laws relating to Dogs, can be purchased (price 2*d.*), either directly or through any Bookseller, from Wyman & Sons, Ltd., Fetter Lane, Fleet Street, E.C.; Oliver & Boyd, Edinburgh; or E. Ponsonby, 116, Grafton Street, Dublin.

4, Whitehall Place, London, S.W.
March, 1897.

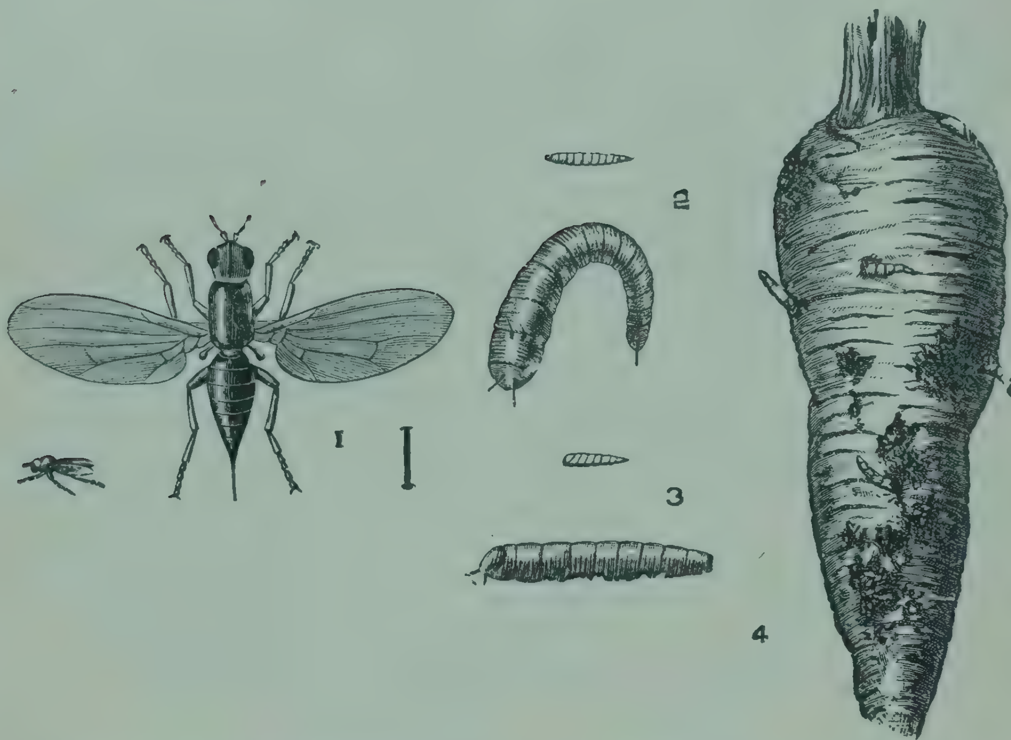
(Last para. revised, December, 1908).

This leaflet is no longer issued separately.

Leaflet No. 38.

BOARD OF AGRICULTURE AND FISHERIES.

The Carrot Fly (*Psila rosæ*, Fab.).



1. Fly, natural size and magnified ; 2. Larva, natural size and magnified ; 3. Pupa, natural size and magnified ; 4. Infested carrot showing "rust" spots.

Carrots are frequently much injured by the larvæ or maggots of this fly, which bore into and feed upon their roots, living upon them and causing them to become brown or "rusty," and finally rotten. In some cases of early attack the growth of the small roots is entirely stopped. Carrots grown by market gardeners and market-garden farmers for "bunching," or pulling early, are not often materially injured, as the fly does not, as a rule, attack them until the end of May, though the latest of these early roots are sometimes disfigured and their value depreciated because of the rusty spots made by the maggot. Those that are dug late for storing, either for human or for cattle food, however, are very frequently seriously damaged, and rot in the clamps and stores, and are rendered unsaleable by reason of the rust marks upon them. It has been noticed that the carrot fly is more injurious in dry seasons, when the growth of the

roots is not so luxuriant and rapid as when moisture is plentiful. The rain also closes the soil, and this may in some degree hinder the fly from laying eggs, the female requiring to go underneath the earth for this purpose.

Carrots badly attacked by this insect sometimes have deep cracks in the roots in which the larvæ are found. These frequently extend to the centre of the roots and cause them to rot. The tops become pale in colour and wither away, and in the early stages of the attack, when as yet there are only a few larvæ in the roots, the foliage changing colour, and turning reddish, betrays their presence. When these indications are noticed it will generally be found upon pulling up the roots that larvæ are protruding from the holes in them (Fig. 4). In bad cases of infestation, decay is frequently hastened by the attacks of millipedes attracted by the unhealthy state of the roots, and by slugs and wood-lice ("Slaters"). The maggots of the carrot fly often remain in the roots after they have been stored and continue to injure them for some time. They have also been reported as attacking turnips in Germany, and celery in the United States.

Description.

The carrot fly is shiny black or dark green in colour and about one-fifth of an inch long, with a wing expanse of nearly half an inch. The wings are iridescent, and have dark yellow veins. The head is round, of a reddish yellow colour and very sparingly covered with hairs. The eyes are black. The legs are of a light yellow colour. There is not much difference between the male and female, except that the body of the latter is more pointed than that of the male, and is furnished with a long retractile ovipositor or egg-laying tube.

The maggot is without legs, yellowish in colour, and nearly a quarter of an inch long. It has no distinct head, but its fore-end tapers to a point, in which there are two claw-like hooks for biting and boring. The hind end is blunt.

The puparium, or pupa-case, is light brown in colour, horny and striated. Its front end is somewhat pointed; the hind end is rounder and bears two small black points.

Life History.

The flies appear in spring, and may be seen upon the lower leaves of trees and bushes, especially near brooks and streams. When the carrot roots are well established the flies lay eggs upon them just below the surface of the ground. All authorities agree that the eggs are laid below the surface of the soil, but none have actually observed how deeply the fly goes down for this purpose. It is believed that it is only just below the surface and that the maggot when hatched goes

down instinctively to the lower part of the carrot, as the root is there softer and more easily penetrated. When it has gained an entry the maggot works upwards and makes passages, with frequent holes to the outside. When young the maggots especially attack the outer parts of the carrot. When full fed they leave the root for pupation in the soil.

There are several generations during the summer. Kühn and Ormerod state that the series of changes is accomplished in between three and four weeks, but in parts of Great Britain it takes very often five weeks. The last generations for the most part remain in the earth in the chrysalis stage.

Preventive and Remedial Measures.

1. When it is noticed that the tops of carrots change colour prematurely, the roots should be examined, and those that are infested should be forked up so that no part of them is left in the ground, and destroyed. This will prevent further infestation.

2. If the flies are seen near or on the carrot plants these should be sprayed with paraffin emulsion. The emulsion is made thus :—Dissolve half a pound of soft soap in a gallon of boiling water ; while this is still boiling hot pour it into 2 gallons of paraffin, and churn thoroughly until a butter-like mass results. If this is well made it keeps for a long time. For use dilute with 20 parts of water. It is better if possible to use soft water in making the emulsion. This emulsion can be put on by means of a knapsack machine, or in large fields by a horse distributor.

3. Spraying the carrot bed with the paraffin emulsion, first, after sowing, a second time after germination, and a third time after thinning, has proved an excellent preventive measure.

4. In places where the carrot fly causes injury, ashes, saw-dust, sand, or wood-ashes, impregnated with paraffin at the rate of from three to four quarts per cwt. may be put into the drills with the seed. Curtis recommends a gallon of spirit of tar to a barrowful of sand for this purpose.

5. Pressing the earth close round the stems tends to prevent the flies from egg laying. This may be done immediately after the plants are singled, by men or boys treading both sides of the rows.

6. Heavy watering of the crop after thinning tends to consolidate the soil, and so ward off attack.

7. Sand or ashes, impregnated with paraffin or carbolic acid, may be scattered over the plants at singling time to keep

the flies from them. The great object must be to prevent the flies from laying eggs on the carrots, and for this purpose offensive substances, such as soot, earth, ashes or sand, sprinkled with carbolic acid, might be applied as soon as the plants are well established. Theobald has reported some benefit from broadcasting over the plants after thinning a mixture of fine soil and washing soda in the proportions of 1 part of finely crushed washing soda to 10 parts of soil

8. It is a matter of common observation that carrots that have sprung up singly on paths or the like, from seed accidentally dropped, are seldom attacked. Apparently the operation of thinning is, in many instances, the predisposing cause of attack, and this has led some growers to sow the seed very thinly, and so to avoid the artificial thinning of the crop.

9. After an infested carrot crop has been removed, the land should be trenched in gardens, and very deeply ploughed in fields. A good dressing of finely powdered gas lime should be applied before the land is dug or ploughed in the ordinary way. The period separating two carrot crops on the same land should be made as long as possible, and recourse should, as frequently as opportunity offers, be made to the cultivation of this crop on fresh ground.

10. Where carrots have been stored in earth, measures should be taken so that any puparia, or maggots which have left the carrots to pupate, may be destroyed.

11. In localities where the attack of the fly is very prevalent a supply of carrots can usually be maintained, (*a*) by sowing such early varieties as French Forcing in a sheltered position as soon as the soil and weather permit in February or March, for early use, and (*b*) by deferring the main crop sowing until mid-July, choosing the Early Horn variety, which will grow sufficiently large for storing for winter use. The plants from the first sowing develop before the egg-laying period of the fly, whilst egg-laying is over before the plants from the late sowing appear above ground.

4, Whitehall Place, London, S.W.,
April, 1897.
Revised, April, 1912.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 39.

BOARD OF AGRICULTURE AND FISHERIES.

Assessments to Land Tax.

The Board of Agriculture and Fisheries consider it desirable to give publicity to the following Memorandum, prepared under the authority of the Board of Inland Revenue, directing the attention of owners of land and other persons to the method by which assessments to land tax are now made, and to the procedure to be followed in cases where persons who may think themselves over-rated to the tax desire to make an appeal.

Memorandum as to Land Tax in England and Wales.

1. The land tax is an apportioned tax. It is not charged at the same rate in the pound over the whole country, but each parish is liable to contribute a fixed annual quota. The parochial quotas were fixed permanently and made perpetual by the Land Tax Perpetuation Act, 1798, but subject to redemption.

2. The land tax quota payable is required by law to be raised in each parish by a new assessment yearly and from year to year at an equal rate on the annual value of all lands and tenements, etc., which have not been exonerated from land tax (Land Tax Redemption Act, 1802, section 180). Such lands and tenements are to be charged "with as much equality and indifference as is possible by a pound rate" (Land Tax Act, 1797, section 4).

3. Formerly the maximum rate of land tax chargeable was 4*s*. in the pound (Land Tax Redemption Act, 1802, section 180). Now, by the provisions of the Finance Act, 1896, section 31, the amount assessed may not exceed the amount which would be produced by a rate of 1*s*. in the pound on the "annual value." For the purposes of that section "annual value" is the annual value as assessed under Schedule A. in the Income Tax Act, 1842, and if an assessment so made on a parish is insufficient to raise the amount of the parish quota the difference has to be written off as irrecoverable.

4. The assessment of the land tax rests exclusively with the Land Tax Commissioners for each division, and any complaint against a land tax assessment on the ground of

inequality or incorrectness must be by way of appeal to them. Notices as to when appeals will be heard are annually fixed early in the financial year to the church door in each parish. The collectors of land tax are required, upon the application of any person who may think himself over-rated, to permit such person, or his proper representative, to inspect the duplicates of assessment at all reasonable times in the day, without payment of fee. Every person intending to appeal is required to give notice of his intention in writing to one or more of the assessors. Appeals once heard and determined by the Commissioners are final.

5. If an owner in possession of the rents and profits of any lands, etc., in any financial year before payment of the land tax assessed on such lands, etc., produces to the collector of land tax a certificate from the surveyor of taxes—(1) that he has been allowed in that year a total exemption from income tax by reason of his income not exceeding £160, the land tax assessed on such lands, etc., will not be collected—or (2) that he has been allowed in that year an abatement of income tax by reason of his income not exceeding £400, one-half of the land tax assessed on such lands, etc., will not be collected.

6. Any person having an estate or interest in lands and tenements (except tenants at rack rent, or holding under the Crown) may contract for the redemption of the land tax charged thereon. By the Finance Act, 1896, the consideration for the redemption has been fixed at thirty times the amount of the tax.

7. Information as to redemption may be obtained from the clerk to the Commissioners of Taxes for the division in which the land tax desired to be redeemed is assessed, or (by letter) from the Registrar of Land Tax, Inland Revenue Office, Somerset House, London, W.C.

No fee is payable by a redemptioner for such information.

4, Whitehall Place, S.W.,
June, 1897.

Revised, May, 1899.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 12 leaflets dealing with Acts of Parliament and Miscellaneous Subjects may be obtained from the same address, price 1d., post free.

Leaflet No. 40.

BOARD OF AGRICULTURE AND FISHERIES.

The Kestrel or Wind-hover (*Falco tinnunculus*, L.).

The beautiful and valuable bird known as the Kestrel or Wind-hover is often wantonly killed either for the sake of shooting at "something wild," and the pleasure of seeing it stuffed and set in a glass case, or because of an exaggerated idea on the part of gamekeepers that it is a systematic destroyer of young partridges and pheasants, grouse, hares, and rabbits.

The wholesale destruction of such birds as the Kestrel is frequently a main cause of abnormal and sudden attacks upon crops by animals and insects. In favourable conditions of climate and other circumstances, and in the absence of the checks provided by nature against their undue increase, certain animals multiply exceedingly and do infinite harm, as was exemplified by the serious injury occasioned to grass-land in parts of Scotland by voles in 1892. Insects also appear more frequently and in larger numbers in these later days owing in some degree to the destruction of certain birds, their natural destroyers.

In his *History of British Birds*, Yarrell says, "Mice form the principal part of the food of the Kestrel," and there is no doubt that small rodents (*e.g.*, mice, field voles and young rats) are favourite food ; while young moles may be taken and also frogs. The Kestrel also feeds on beetles (*e.g.*, cockchafers), on grasshoppers, and on insect larvæ,—a Kestrel has been found containing as many as 178 wire-worms. When it cannot get mice it will occasionally take very young birds, as pheasants, partridges, and grouse, but practically all observers agree that it preys chiefly upon mice and insects, a statement borne out by examinations and dissections of the castings or pellets thrown up by the bird. In the report of the Departmental Committee, appointed by the Board of Agriculture to inquire into a plague of field voles in Scotland in 1892, it is stated that the food of the Kestrel is known to consist almost exclusively of mice, grasshoppers, and coleopterous insects.

Keepers do not always discriminate between hawk and hawk, and because some other hawks, as the Sparrow-hawk, for instance, take young game birds, it is often erroneously concluded that the Kestrel is equally an offender in this respect. In the report referred to above, it is observed, in connection with the question of the Kestrel's habits, that it

is rare to find people able to distinguish between one kind of hawk and another. Few of the witnesses who gave evidence before the Departmental Committee were able to describe hawks otherwise than as red, blue, brown, or yellow, and it was often found impossible to make out what species they intended to indicate.

The identification of the Kestrel is easy on account of its practice of hovering in the air, without motion, for a long time; it is further distinguished by its chestnut colour and its long pointed wings. Its graceful flight is different from the rapid dashes of the Sparrow-hawk. It is about fifteen inches from head to tail, the female being slightly smaller.

The colour of the Kestrel is reddish-brown to pale-chestnut, with small black or bluish-black bars or spots on the back, according to sex, the male having spots, the female bars. The under parts are buff, streaked and spotted with black. The head, neck, the lower back, and tail are bluish-grey in the male. The tail is edged with white below a broad black band, while in the case of the female there are several dark bands on the tail. The beak is blue, except the base (cere), which is yellow, as also are the legs and feet. Old females often partially assume the appearance of the male.

The Kestrel seldom, if ever, builds a nest, but makes use of the old nest of a crow, rook, magpie, or similar bird, or else lays its eggs in cavities in cliffs, quarries, chalk-pits, hollow trees, or buildings. It has now and then been known to lay eggs on the ground. The eggs are usually laid in the latter half of April, and vary from four to six in number. They are yellowish-white mottled with deep brownish-red patches. During their first year the young resemble the female, but are a little lighter in colour.

There is testimony from many writers as to the value of the Kestrel to the agriculturist as a mouse destroyer, notably from Charles Waterton and White of Selborne. Amongst continental authorities Ritzema Bos speaks of the great usefulness of the Kestrel to cultivators in Germany; and in France, according to Brocchi, it is also highly valued.

4, Whitehall Place, S.W.,
August, 1897.

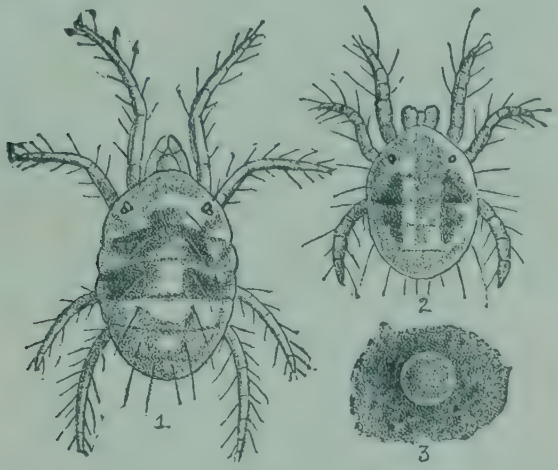
Revised, May, 1908.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

THE KESTREL OR WIND-HOVER (*Falco tinnunculus*).

BOARD OF AGRICULTURE AND FISHERIES.

Red Spiders (*Tetranychus*, *Bryobia*, and *Tenuipalpus*).



1, A full-grown Red Spider. 2, Immature mite, with six legs. 3, Egg. All much magnified.

One of the families of Mites, the *Tetranychidæ*, sometimes known as Red Spiders or Spinning Mites (many of the species can spin silken threads) contains three genera troublesome to plants, viz., the genera *Tetranychus*, *Bryobia*, and *Tenuipalpus*. These may be thus distinguished :—

Tetranychus has a somewhat pear-shaped body, which is half as long again as broad, the front pair of legs being longer than the body.

Bryobia has the two front legs not only longer than the body but distinctly longer than its other legs.

Tenuipalpus has short heavy legs.

The damage is in all cases due to the piercing of the plant tissues by the sharp mandibles.

A species of red spider (*Tetranychus althææ*) sometimes causes serious injury in hop plantations. In 1868, and again in 1893, this pest did much mischief in many hop grounds. The leaves fell off, the burr or blossom did not develop into cones, and, in some instances, the plants were completely shrivelled up. In most seasons, at least in those in which rainfall and temperature are normal, a few spinning mites can be found upon the large leaves of the hop plants, especially where the soil is shallow, but in the two years mentioned above they multiplied with wonderful rapidity. They were found upon the small leaves high up the poles, also upon the burr, and even in the cones themselves.

Life History.

The spinning mite of the hop plant passes the winter in the perfect state under stones and clods, in the bark of trees, and in the clefts and under the dried rind of hop poles. It is not noticed, at all events in numbers or as actively injurious, unless there is at least normal summer-heat, and it only multiplies in a dangerous degree when the day and night temperatures are abnormally high. In such circumstances the increase in its numbers and the rapid spread of its destructive influence are remarkable.

The comparatively large eggs are pellucid white at first and finally become slightly dark-coloured. They are globular, and are placed in the space between the ribs of the leaves. A close inspection with a microscope will show that they are kept in this position by means of fine threads stretched from side to side. A female *Tetranychus* may lay more than 100 eggs, and by a week and a half the larvæ from these may be adult.

The mites emerge from the eggs in five or six days, and at once begin to suck the juices of the leaves. At first the creatures are pale greenish-yellow in colour, with dark patches on both sides of the body; they become more tinged with yellowish-red later, and some very light brown specimens have been found, whereas in other cases they are seen to be of a distinctly red colour. Red spiders in different stages of development may be found at the same time.

In the earlier stages of their existence the mites have only three pairs of legs, but when full grown they have four pairs. The head is provided with a stout pair of mandibles with hooked ends for biting into the tissues of the leaf, and the mouth has a sucking apparatus which is inserted into the tissues. On the under side of the mite, towards the end of the abdomen, there is a conical nipple, from which the threads of the web are drawn out and guided by the motions of the mite and by the action of the minute claws and hairs of the legs.

A badly infested leaf has its under side completely covered with a dense web of fine silk, in which eggs are found in abundance as well as numbers of mites of all sizes sucking up the juices of the leaf. The leaf becomes yellow and mottled, and, as a rule, finally falls off, when the mites escape on to the earth. Mites left on the leaves upon the hop plant retire into the cracks and under the rind of the poles; they have great power of locomotion, and travel very rapidly quite independently of their webs.

Red Spiders are also very harmful under glass. They form one of the most serious pests in green-houses and vineries (*Tetranychus telarius*); melons and cucumbers are also attacked (*T. cucumeris*). Theobald has recorded

T. anauniensis on sweet scented lemon. The different species can be identified only by specialists. They have, however, very similar habits and may be killed by the same wash.

The Red Spiders of fruit trees belong to two genera, *Bryobia* and *Tenuipalpus*. The former are most destructive, *e.g.* the *Bryobia*, on the Gooseberry and Currant. A common species (*B. prætiosa*) is found on ivy. These mites have very long front legs and spin but a scanty webbing. The eggs may be found on the bushes all the winter, as also may those of the *Tenuipalpus*. When present in numbers the mites soon cause the leaves to become unhealthy and fall off.

The colour of the *Bryobia* is variable like that of the Red Spider on hops, but is usually various shades of red, darkened at the sides. The *Bryobia* mites are active from March onwards and may lay eggs in April, May and June. The eggs are shiny red and are placed in the axils of twigs and between the remains of old bud-scales. While eggs laid early hatch soon, eggs laid late may remain on the trees right through the rest of the summer and winter. The Red Spiders of the other genus, *Tenuipalpus*, live in a similar way, but their work is not so evident. This genus receives its name from the small and slender palpi which end in short bristles. The colour of these mites is red.

Prevention and Remedy.

1.—It is most difficult, in fact it may be said to be almost impossible, to prevent mites from getting on hops and fruit trees. They are most agile in movement, and travel rapidly. Hop plants on wire and string seem equally liable to attack, as the mites crawl up the bines. The application of caustic substances close round hop hills is ineffectual. It is also almost impossible to get at the mites in the cracks of the poles and posts of hop gardens. When a drought commences in June and there is a probability of its continuance, it would be useful immediately to syringe with cold water hop and other plants upon which the mites are seen, or with water and liver of sulphur, or with paraffin emulsion before the webs are made or before they are plentiful and thick. To be effectual, syringing must be done early, vigorously, and abundantly. When the webs are well established, even the most drastic syringing is often unsuccessful.

Species of *Bryobia* forming but a scanty webbing are more easily killed.

2.—Liver of sulphur (sulphide of potassium) at a strength of from 2 lb. to 3 lb. dissolved in 100 gallons of water is now used against Red Spiders.

3.—Paraffin Emulsion. In the Eighth Report (1908) of the Woburn Experimental Fruit Farm a paraffin emulsion recommended is composed of:—Sulphate of iron, 5 lb.;

caustic lime, $2\frac{1}{2}$ lb.; paraffin (solar distillate), 10 to 15 lb.; water to make 100 gallons. This has been modified to:—Iron sulphate, $6\frac{1}{4}$ lb.; lime, 3 lb. 2 oz.; paraffin (solar distillate), 15 lb.; water, 100 gallons. To prepare:—Dissolve the iron sulphate in water; slake the lime in part of the water; add the lime water to the dissolved iron sulphate and churn in the paraffin. Add water to make up to 100 gallons.

4.—Paraffin Emulsion and Liver of Sulphur. Good results attend the use of a combination of liver of sulphur and paraffin, and Pickering and Theobald recommend the following formula:—Iron sulphate, $1\frac{1}{4}$ lb.; quicklime, 10 oz.; paraffin (solar distillate), 10 to 15 lb.; potassium sulphide, $2\frac{1}{2}$–$3\frac{3}{4}$ lb.; water to make 100 gallons. To prepare:—First dissolve the iron sulphate in some water, slake the lime in water, and mix; next churn in the paraffin; dissolve the potassium sulphide in the bulk of the water, and finally pour in the paraffin emulsion and thoroughly mix the whole.

Where the spraying is done in late spring or summer it should be repeated in a week or ten days in order to reach the young mites that have in the interval hatched from eggs unharmed by the first spraying.

5.—For vines, cucumbers, melons, &c., the liver of sulphur can be used mixed with quassia wash.

6.—Sulphur mixed with water and painted on the hot-water pipes is often employed in conservatories. With such a use of sulphur care must be taken to maintain a proper degree of moisture in the greenhouse. Apart from the danger of this treatment if the atmosphere of the house be dry, one of the great causes of the prevalence and multiplication of Red Spider is overheating and over-dryness, and where forcing is practised and the temperature is therefore high the question of moisture should be attended to.

7.—Under glass, fumigation with tobacco is a common and usually a fairly effective remedy.

8.—Fumigation with hydrocyanic acid gas as described in Leaflet No. 188 is a valuable method for destroying Red Spiders in greenhouses, &c.

4, Whitehall Place, London, S.W.,
April, 1898.

Revised, August, 1910.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

The Short-Eared Owl (*Asio accipitrinus*, Pallas).

THE SHORT-EARED OWL.
Otus brachyotus (*Strix brachyotus*).

The Short-Eared Owl is from 14 to 15 inches in height. The female is rather larger than the male. The head, back, and wings are lightish brown, with darker brown patches upon them. The wing feathers have an edging of light buff or fawn colour, and the under surface of the body is of this colour with blackish markings upon the breast. The

legs are pale buff and the toes black. The beak is also black, and the ears, as well as the tufts of feathers on the head, are brown. The eggs are creamy white in colour, and about $1\frac{3}{4}$ inches long by $1\frac{1}{4}$ inches in breadth. They are deposited on the ground in a nest scooped out of the earth and lined with a little dry grass or moss. The nest is made generally in tufts of heather or furze, or on the top of a clump of sedge or reeds in fen districts. Nests have been occasionally found in the Kentish marshes on little hillocks covered with rushes. From six to eight eggs are generally laid, but, as was shown by evidence before the Committee cited below, as many as 13 eggs have been found in a nest. Seebohm, in his "Far Countries of North America," quotes Richardson to the effect that this species of owl lays as many as 10 to 12 eggs.

This Owl differs somewhat in its habits from other owls found in Great Britain, which live in thick woods and plantations, or in barns, churches, and ruins, and seldom leave their retreats during the day. The haunts of the Short-Eared Owl are heath and moorland, marshes, furzy downs, meadows, turnip fields and open places, principally in the north of England and Scotland, though it is found occasionally in many English counties. It flies in the day-time as well as at night. Its food consists of mice, voles, rats, small birds, fish, reptiles, large insects, and occasionally bats. Prentis, in his *Birds of Rainham* (Kent), says that the Short-Eared Owl is not uncommon, and comes in the autumn. It visits the marshes, where it is safe, nearly every year. When partridge shooting, sportsmen have met with these owls in Kentish turnip-fields. On one occasion a pair nested and succeeded in hatching their young on an island marsh which had been lying idle throughout the winter and spring. But this owl, being migratory, does not, as a rule, breed in Great Britain; it leaves this country at the beginning of the spring for many other countries, so that, to use Seebohm's words, outside our islands its range is almost cosmopolitan. It is found in such different latitudes as the Sandwich Isles and Greenland. Sometimes, however, as ornithologists relate, its nest is found in this country, especially in districts where there has been an extraordinary supply of its favourite food—mice, voles, or rats. In Gloucestershire, for example, when there was a great plague of mice in the Forest of Dean, Short-Eared Owls were attracted there in large numbers and materially assisted in destroying the intruders. The birds also proved markedly useful during the last severe plague of voles in the south of Scotland.

The Departmental Committee, appointed in 1892 by the Board of Agriculture to inquire into a plague of field voles in the south of Scotland, say in their report, "This bird (*i.e.*, the Short-Eared Owl), which is distributed over almost

every part of the globe, is a normal winter migrant to these islands, appearing simultaneously with the woodcock (whence it is popularly known as the 'woodcock owl') and usually departing in spring. Nests in ordinary seasons are of comparatively rare occurrence in Great Britain, but in consequence of the vast multiplication of their favourite food, the vole, these owls have not only arrived in unusual numbers but have remained and bred freely all over the district affected, laying from 8 to 13 eggs (though Newton in his edition of Yarrell's 'British Birds' mentions seven as an unusual number) and rearing more than one brood. The shepherd on Crooked-Stone, near Crawford, has counted 14 nests on his ground."

The Committee were of opinion that it would be difficult to condemn too severely the foolish and cruel action of those who allow or encourage the destruction of this useful and beautiful bird, and it was with much satisfaction that they were able to record that many land owners and game preservers had become convinced in late years that owls of all sorts are not only harmless to game, but most beneficial to agriculturists, and had issued orders for their preservation. Seebohm also writes strongly: "Too often, however, the poor harmless owl is shot down by the thoughtless farmers, or ignorant gamekeepers, who foolishly imagine they are ridding the domains of a pest, although in reality they are taking the life of one of their most valuable friends."

The Short-Eared Owl is much appreciated in Germany, where it is called the "moor," "fen," and "meadow" owl. It occasionally breeds in Germany as in England, while it also breeds, but not extensively, in certain Southern Departments of France.

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Leaflet No. 43.

BOARD OF AGRICULTURE AND FISHERIES.

Titmice (*Paridæ*).

THE GREAT TITMOUSE (*Parus major*).

All the titmice are more or less active hunters of insects, for which they are constantly on the watch, and no inhabitants of the insect world come amiss to them as food. They are especially useful in the destruction of many crop pests, which they devour in all stages. During the winter they clear off enormous quantities of eggs which have been deposited by insects of various kinds in or near buds, and in the clefts of the bark or rind of trees. At this season the titmice may be seen frequently running up and down the trunks, stems, and branches, or hanging head downwards from the smaller branches and twigs, prying anxiously into each crevice and fold of the rind, in search of eggs, hibernating larvæ, or perfect insects. Their sight is so keen that they can detect such small eggs as those of the Winter Moth, and they have been seen actively devouring the minute red eggs of the mite *Bryobia* upon the stems and branches of gooseberry bushes and damson trees.

It is sometimes alleged that the tits, like the sparrows, wantonly pick out the buds of trees and shrubs; but this accusation is wrong, and based upon insufficient investigation

of the circumstances, as titmice only attack buds that are diseased.

The Crested Tit (*Parus cristatus*).

The Crested Tit is a pretty little bird, but it is very scarce and decreasing in numbers, forests in the north or north-east of Scotland being its chief and almost only habitat in Britain. It can be recognised by the feathers of the head being prolonged into a crest, black in colour but edged with white, and by the black streak which runs backwards from each eye and then round the cheeks. The crest of the female is not so conspicuous. Nesting takes place in May; eight eggs are laid, white in colour and spotted with red. The Crested Tit feeds on insects and weed seeds, and should be carefully preserved.

The Coal Tit (*Parus ater*).

Living as it does chiefly amongst pine and birch woods, often far from houses, the Coal Tit is not so well known as the Great Tit and the Blue Tit. It is, however, as great a destroyer of insects as the other members of the same family, and should be rigorously preserved. It is found throughout the British Isles.

The Coal Tit is rather more than four inches long. Its general colour is bluish grey, with a dull white breast, and it may be distinguished from the Marsh Tit, which it somewhat resembles in colour and size, by a large white patch on the back of the neck and by the two white bars on the wings. It usually makes its nest in holes in trees; but it occasionally nests in burrows and holes in the earth made by rabbits and other animals. The eggs are white, spotted with red-brown.

The Marsh Tit (*Parus palustris*).

This Tit is occasionally seen in gardens and orchards, principally in the winter, but its chief habitations are low-lying meadows and damp situations, where it nests in holes in old willow-trees and other trees, pollards, and stumps, very close to the ground. After *Parus cristatus* it is the least common of the Tits. Like the other British Tits it is insectivorous, though Yarrell states that it is also partial to the seeds of the thistle. The young keep together for some time after they are fledged.

According to Seebohm it may be seen in almost every conceivable position searching for insects on the buds at the end of a branch. It is slightly smaller than the Coal Tit, its head is bluish black, the sides of the neck are white, the under part of the body is light brown while the upper part is olive-brown, of varying shades. The 5 to 8 eggs are greyish white speckled with brown.

The Great Tit (*Parus major*).

Two of the tits are especially useful to agriculture, because they are not only more numerous than the other members of the family, but they live near human habitations, and are found in every garden and orchard. The first place in point of size may be given to the Great Tit, which is a voracious devourer of insects of all kinds and in all stages. It is indefatigable in search of food, and may often be observed climbing the trunks of trees, or hanging suspended from the under surfaces of branches while examining every cavity, leaf, or bud that is likely to afford shelter to any of its numerous insect-prey. These tits have been observed in numbers upon and under oak trees, pecking to pieces the galls for the sake of the insects within. Late in the autumn, small seeds and fruit form part of its diet, but its young are fed entirely on small caterpillars and grubs. Apart from the courage displayed by the Great Tit in defence of its young it has been seen to attack and kill other small birds.

The Great Tit, called also the Ox-eye, is a beautiful bird about six inches long, and usually builds its nest in holes in walls, trees, decayed posts, and similar places. Six, seven, or eight is the average number of eggs, which are white, sometimes a faint yellow, and spotted with red. The head and throat of the Great Tit are glossy black, with a white patch under each eye. The back is olive, or ashy green, and the body underneath is greenish yellow with a broad stripe of black down its entire length.

The Blue Tit (*Parus cœruleus*).

This elegantly feathered little bird is the most useful of all the tribe of tits. It is about four-and-a-half inches in length, and happily, distributed generally throughout the country. The wings and tail of this species are blue, the breast and belly sulphur-yellow, the back yellowish green, and the side of the head white with a blue band running across it from the beak to the nape. Its nest of moss, hair, and feathers is built in holes in trees, walls, or gate posts, and sometimes in pumps, letter boxes, and other extraordinary places. The egg are six to nine in number, and are white, spotted with light red. Insects appear to be the principal objects of its search during the summer. Naturalists who have watched these birds saw nothing but small grubs and caterpillars brought to the young ones from apple trees near. In the winter this tit feeds upon seeds, eggs and pupæ of insects, and anything it can pick up.

The Long Tailed Tit (*Aegithalus vagans*).

This tit which is abundant in the southern and south-western counties of England, but not so common in the

north, is also beneficial. It is about four-and-a-half inches long, and builds a most elaborate nest, shaped like a bottle, from which this bird is known familiarly in some localities as the "Bottle Tit." The nest, which is built in thick bushes or dense shrubs, has a very small hole in the upper part of the side. The eggs vary in number from ten to sixteen and are white with faint red spots. It is stated that this bird is more decidedly insectivorous even than the other species of tits. Brocchi maintains that it feeds entirely on insects in France, and that it and all the species of tits have a right to the protection of agriculturists, to whom they render important services. He estimates the annual consumption of each of these birds at nearly 200,000 insects in the form of eggs and larvæ, and remarks that when they attack the buds of fruit trees, an offence with which they are sometimes charged, it is certain that there are insects or mites within these buds.

The head, breast and neck of the Long Tailed Tit are whitish, with black bands or stripes. The back is black, mixed with rose colour, and the wings and the very long tail are black edged with white.

THE BLUE TIT (*Parus cœruleus*).

There is no doubt that the Great and Blue Tits occasionally damage apples and pears by pecking holes in the base; and it is believed that this may occur even when no insects are in the fruit. This destructive habit can easily be

checked by growing rows of sunflowers in and around the orchards. The Tits feed greedily on the seed, and are thus kept away from the fruit; and at the same time they are attracted to the orchards where they do much good in checking insect depredations. In a case where the Blue Tit damaged the pear crop by perching above the stalk of the nearly ripe fruit and pecking it, so causing the pears to fall, protection was afforded by the use of small shields of cardboard. The pears were large and valuable and were being grown on bushes; cardboard shields were cut two inches square, with a hole in the centre and a slit on one side so that they could be fitted round the stalk of the pear. The Great Tit also attacks nuts; but the good it does in devouring the nut maggot outweighs the harm it now and again does to the sound nuts.

So beneficial in every sense are the Tits that everything possible should be done to encourage their increase. In winter, during severe weather, they should be supplied with some food, *e.g.*, fat, acorns, or beech nuts. Where old trees and walls are abundant the Great and Blue Tits usually find ample opportunities for nesting, but under other circumstances, the birds may be rare or altogether absent, owing to their inability to find nesting places. In such a case much may be done by fixing up rough boxes in suitable places, care being taken (*a*) that they are placed beyond the reach of cats, (*b*) that they are as inconspicuous as possible, and (*c*) that the entrance hole is not large enough to admit sparrows. It must be said, however, that Tits do not take nearly so readily to artificial nesting places as some other birds, notably Starlings.

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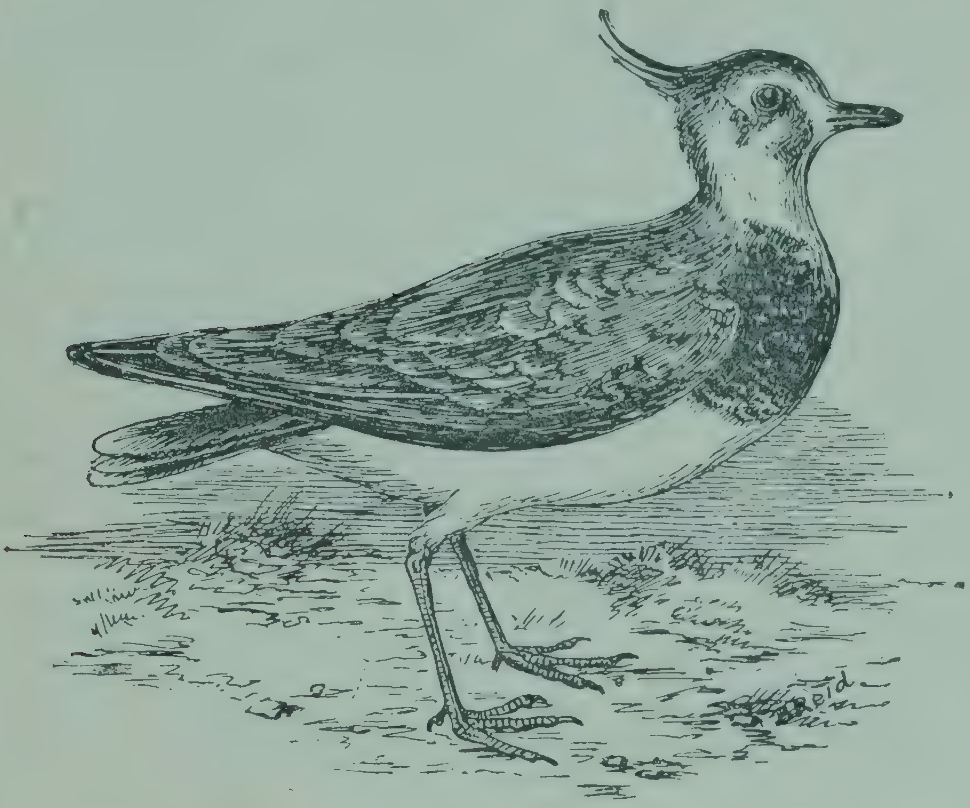
A pamphlet containing 11 *leaflets dealing with Wild Animals and Birds may be obtained from the same address, price* 1*d. each, or* 9*d. per dozen, post free.*

BOARD OF AGRICULTURE AND FISHERIES.

The Lapwing, Green Plover or Peewit.

Vanellus cristatus, M. and W. (*vulgaris*, Bechstein).



This bird is familiar to most persons in Great Britain and Ireland, being found in every county. It breeds in marshes, moors, meadows, and fallows, and is seen in large flocks in the autumn and winter, but in the breeding season the flocks are not nearly so large as at other times of the year. Large numbers arrive every autumn from the Continent. In the adult bird the beak, crown of the head, and the erectile crest are greenish-black; the back and wing coverts are also green-black, tinged with purple and copper-colour; the sides of the neck are whitish, and the lower part of the breast and the belly are white; the wing quills are black; the feathers of the tail are white, a broad black band showing near their tip. In winter the throat becomes white and the head dark brown. The bird measures a foot in length.

The nest of the lapwing or peewit is a mere hole or depression in the surface of the ground, either in grass land or arable land, sometimes with a few bits of dried grass, bents, or rushes at the bottom. Nesting takes place at the end of March. The olive-coloured eggs with black-brown blotches, familiar to everyone, are usually four in number, and are keenly sought after in districts frequented by these birds, to supply the great demand for them as luxuries of diet. Such high prices are paid for plovers' eggs, especially in the early part of the season, that the natural increase of the birds is largely interfered with, and the multiplication of insects injurious to crops is the consequence.

The Lapwing is entirely beneficial to cultivators. It devours snails, wireworms, beetles, and larvæ of various insects that infest grass, turnips, wheat, and crops of other kinds. In recently-made dissections Newstead found many "leather-jackets," and some full-grown caterpillars of a Noctuid moth, in the stomachs of Lapwings. As the Lapwing feeds in the evening, it has opportunities of taking many insects which commit their depredations after sundown. On account of their insectivorous habits lapwings are sometimes kept in gardens, where their valuable services are highly appreciated. They also eat small molluscs, and are of benefit to sheep owners by eating the water snail of the species *Limnæa truncatula*, as this snail is the intermediate host of the liver fluke (*Distoma hepaticum*) which produces the liver-rot in sheep.

Lapwings are, fortunately, protected in close time throughout Great Britain by the Wild Birds' Protection Act of 1880. The eggs are protected, by the adoption of the Wild Birds' Protection Act, 1894, after April 15th in all counties in Scotland ; and in a few counties in England the second brood of eggs is protected by prohibiting the taking of their eggs after May 1st. The following testimony of Curtis, the great economic entomologist, may be cited in favour of these birds :—"In the marshy districts of our Eastern counties," he says, "the plover, or lapwing, called also 'pewit,' was formerly exceedingly abundant, as well as the ruff and ree, but the gun and nest-hunter have so thinned their numbers that the lapwing is becoming scarce, and the latter have almost abandoned our shores, and as might be expected, the Wireworms seem to be increasing rapidly in such localities. On opening the lapwings that have been shot, their crops were full of Wireworms ; and as it is supposed that one bird would eat a hundred in a day, the flocks of forty, fifty, and upwards that were constantly to be seen some years since would clear off a very large number in a season. Their assistance, however, is departed

and gone for ever, for the high price which the eggs fetch in the market causes the peasantry to look so carefully after the nests, that the only chance the lapwing has of escaping destruction is to seek the wildest districts of Scotland and Ireland, where, their eggs not being so essential a luxury as they are considered in England, they may escape the persecution they have so long endured. Whether the destruction of late years of whole fields of corn at Oxborough, near Stoke in Norfolk, is attributable to the absence of these birds, I cannot say, but it is certain that formerly the plover abounded in that neighbourhood, and now scarcely a pair can be seen." Since Curtis wrote these words,* the demand for lapwings' eggs has greatly increased, and the annual search for them is even more persistent than it was fifty years ago. In the agriculturist's interest the eggs should be protected in all counties.

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* Journal of the Royal Agr. Soc., 1844, Vol. V, Part I. p. 208.

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Leaflet No. 45.

BOARD OF AGRICULTURE AND FISHERIES.

The Starling (*Sturnus vulgaris*).

The starling is so well and widely known throughout Great Britain and Ireland as hardly to need description. It is nearly 8½ inches in length. The beak of the adult male is yellow; the head, neck, and back, and all of the under part of the body are glossy black, with metallic purple or green tints; the feathers on the upper parts are tipped with buff or dead gold colour; and the wings are greyish black with a fringe of reddish brown; the legs and feet are red-brown. In the adult female the colour is similar, but not so glossy and lustrous as in the male, and the body is more spotted. The young birds are unspotted, uniform ash-brown above, clouded with white on the under surface. In the autumn the adults are somewhat lighter in colour, and lose the metallic lustre in some degree.

Pairing takes place early in the year, depending on the weather, and eggs are generally found in the first weeks of April. The starling builds without much care or art, in holes almost anywhere—in trees, eaves of buildings, church towers, caves, clefts, and rocks. It has also been observed to build openly in creeping plants against a wall, and in the thicker and uppermost branches of the spruce fir, the nest being placed close to the stem. In most cases, twigs, straw, hay, grass, moss, or wool are used to line the nest, but

sometimes scarcely any lining is supplied. Four to seven eggs are laid (5 or 6 on the average), these being pale blue in colour tinged with green, and very slightly more than an inch long. There are often two broods in the season, and eggs are found from early April until the end of June.

Starlings have increased very markedly of late years. This is due partly to the protection which they enjoy, and partly to their power of rapidly moving from place to place according to the abundance or scarcity of food. They are strong and bold birds, and are not driven away from their nesting places by other birds.

Starlings almost invariably utilise holes for breeding, and they have, both in Belgium and Germany, been long supplied with artificial nesting-boxes where natural nesting-places are not available. A box 10 to 12 inches in depth, and 6 inches by 6 inches in cross section, with a sloping and slightly overhanging roof, and a hole near the top 2 to $2\frac{1}{4}$ inches in diameter, with a perch below, will not usually remain long tenantless. It is best fixed on the sheltered side of a tree or wall.

When the nights begin to get cold in autumn starlings congregate in large flocks, and frequent by preference moist marshy districts. They spread over fields and meadows in search of insects by day, and at night return to their roosting places, which may be shrubberies and plantations, or beds of reeds or osiers. The aerial evolutions preceding roosting in autumn have repeatedly excited the admiration of observers. According to Seebohm a large flock of starlings will divide into several parts as the night approaches, each going to a separate roosting place. He adds: "Starlings often congregate with rooks and jackdaws in the autumn on the pastures, and later in the year with redwings. When alarmed, the starlings, as if to a bird obeying a commander's voice, fly off in a compact mass, and if the danger soon passes, they will wheel and return again in the greatest order."

In hard weather, and when food is scarce, the starlings migrate to parts of the country where frost is not so intense, but they ultimately return to their native places, and the same pairs occupy their accustomed nests.

Food of Starlings.

Insect Food.—The starling is of much benefit to agriculturists, as its food consists principally of worms, snails, and insects in their different stages. It is especially useful in clearing off chafer larvæ, and other larvæ of the same habits, in meadows and pastures, and surface caterpillars in turnip and mangold fields. The destructive larvæ of the Antler moth, the Diamond Back moth, the Silvery Y moth, and of other moths, as well as those of the Daddy Longlegs, and of

the Click Beetle (known as wire-worms), are also eagerly devoured by this bird. In the late autumn and winter, when the starlings congregate in flocks they clear whole fields of injurious insects in larval or pupal form, and their sharp eyes detect the eggs of at least the larger insects upon forest and orchard trees. The insects that hibernate in the larval or pupal form upon fruit and other trees are, without doubt, picked out of their winter quarters by the long, pointed beaks of these sharp-eyed restless birds.

Some years ago, in a large and richly stocked nursery in Belgium, chafer beetles became so numerous as to be a very serious infestation. After trying by all known means to eradicate them, the proprietor observed that starlings devoured large numbers both of the larvæ and the mature insects. He therefore erected about half-a-dozen nesting-boxes on 15-feet poles, and as these were immediately occupied by the birds he continued to provide boxes until 125 were in use. The result was that the chafer infestation grew gradually less and was finally completely overcome.

Sheep regard starlings as their natural friends, and permit them to alight on their backs to take out the keds, ticks, etc., from their wool. Some farmers, however, maintain that the droppings which starlings deposit on the backs of sheep attract flies, and that sheep are not infrequently "struck" by maggots exactly on the spot (the loins) where the birds most usually settle. In early summer it will often be found that cattle on pastures are accompanied by starlings, each animal being surrounded at a distance of a few feet by about half a dozen birds. Whether these are attracted by the worms that are apt to come to the surface of the ground when disturbed by the treading of cattle, or are on the look-out for the maggots of the warble fly, which in spring and early summer drop from the backs of cattle, has not been definitely made out. Starlings may often be seen accompanying rooks in meadows and fields in a joint search for insects. In the summer a pair of starlings may often be seen in meadows and fields near their nesting place, surrounded by five or six young ones, busily engaged in hunting for insects. Broods frequently keep together until the autumn, when they join the flocks congregated for the winter.

In the breeding season the quantity of insects consumed by starlings is enormous. A single starling has been seen to carry food to its young, from a grass paddock 100 yards distant from the nest, as many as eighteen times in fifteen minutes. In another case, between May 30th and June 8th, 1908, a total of 17 hours was devoted to observing a pair of starlings bring food to their three nestlings.* During that

* "The Food of some British Birds," R. Newstead, M.Sc. (*Supp. Jour. Bd. Agric.*, Dec., 1908).

time (representing approximately the hours of one day during which food was collected) 169 journeys were made to the nest by the parent birds. The food brought to the young was approximately as follows :—269 insects of the injurious group (very many large caterpillars), four insects of the useful group, two of the indifferent group, 30 earthworms, 14 slugs and snails, one centipede, one wood louse, two harvest spiders, 23 lots of bread, 19 lots of garbage (?), and 10 lots of unidentified insects. These figures represent but a small portion of the food actually brought in during the days of observation. It is clear, therefore, that starlings, when feeding their young, destroy an enormous quantity of harmful insects.

Vegetable Food.—During the year 1904 many complaints were made of the depredations of starlings, not only in the Kentish cherry orchards, but in apple and pear orchards and in connection with other fruit. Wheat also has been frequently attacked, and in some districts fields of seed-wheat have apparently suffered heavily. In one or two instances when birds have been opened, the crops and gizzards have been found to contain whole and partly digested seed corn, whilst the birds have been seen at work in the field pulling up and devouring the sprouting grain.

Summary.

On the one hand :—

1. The starling feeds principally on worms, snails, chafer larvæ, and beetles, wireworms, surface caterpillars, larvæ of daddy longlegs, and many other harmful insects, together with pupæ and eggs.

2. The starling is entirely useful on newly ploughed land, and in meadows and pastures.

On the other hand :—

The bird devours or spoils cherries, apples, and pears, and other fruit to a less extent, whilst it is sometimes destructive to seed-wheat.

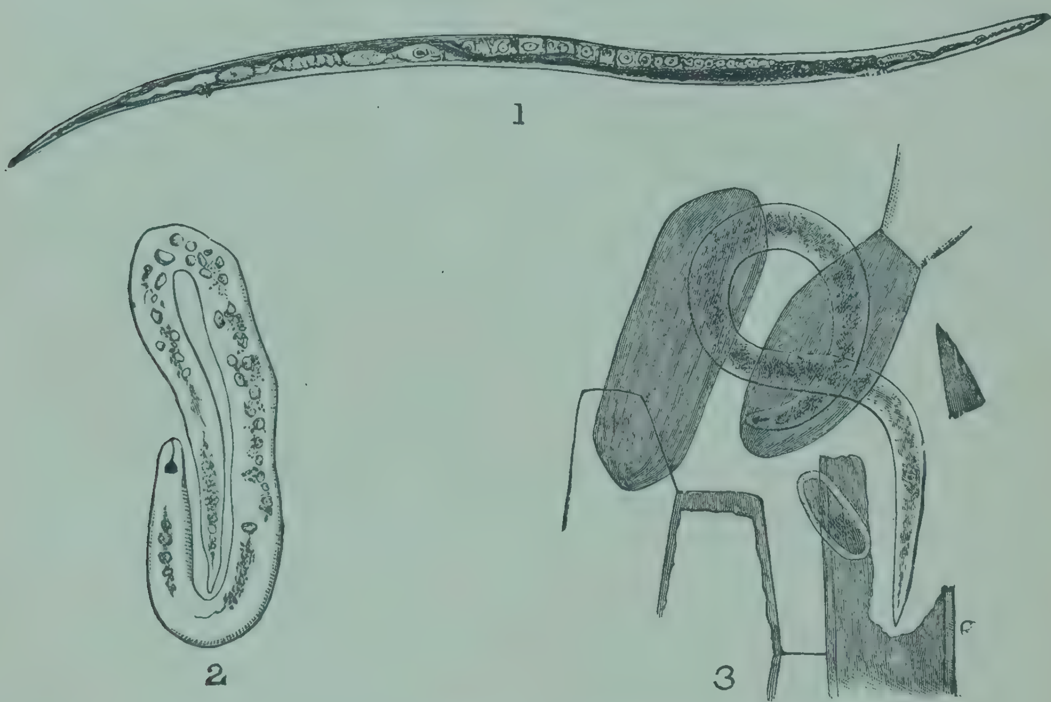
There is no doubt that starlings do much harm in the orchards of this country when the fruit is ripening. On the whole, however, the information at present collected goes to show that, in view of their great partiality for insect food, starlings are, from the forest standpoint, entirely useful, whilst in agriculture and gardening their usefulness far more than outweighs the occasional harm done.

4, Whitehall Place, London, S.W.,
October, 1897.
Revised, February, 1911.

Leaflet No. 46.

BOARD OF AGRICULTURE AND FISHERIES.

The Stem Eelworm (*Tylenchus devastatrix*, Kühn).



1. Eelworm. 2. Young form just emerged from egg.*
3. Eelworm and egg in plant tissues.
(1 much magnified, 2 and 3 more highly magnified.)

The mischief caused by the stem eelworm (*Tylenchus devastatrix*) appears to be extending. For some years past complaints have been received of the failure of various kinds of crops from some unperceived cause, which, on examination, proved to be the stem eelworm. Wheat, oats, hops, clover, and onions were the principal subjects of this infestation submitted for investigation, and in all cases eelworms of this species were found in the stems of the affected plants.

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* These figures are reproduced from Dr. Ritzema Bos' *L'Anguillule de la Tige*, with his courteous permission.

As a rule, there were no signs of any insect or fungoid attack, except in some of the diseased clover plants, in which there were fungi present, together with the eelworms. In some specimens of diseased clover plants from large fields where disease was rampant, the stems of the affected plants were swarming with eelworms; there was also in the same plants injury caused by the action of the fungus *Sclerotinia trifoliorum* (Erik.). It was difficult to determine whether the *Tylenchus* or the fungus was the primary source of the injury to these clover plants. In some other plants examined, the cause of the disease was certainly *Sclerotinia*, as there were no eelworms present.

Among Leguminosae red clover is especially subject to infestation by these eelworms, but lucerne is also attacked. While the clover plants are small, and during winter when their growth is practically arrested, the eelworms get the upper hand of them, the result being one of the conditions generally called "clover sickness." In clover fields left down for two years, bare patches, which extend widely in the second year, are often seen.

Infestation of wheat plants is not very common, but it does sometimes occur, and causes harm, most frequently, in wheat sown in the spring. In bad cases densely matted stems swollen at the base are produced, many being bulbous, or "tulip-rooted." Upon stripping off the sheathing leaves the inner leaves are found to be in a flabby condition, and microscopical examination will show that they are swarming with eelworms. The sheathing leaves may have eelworms within their tissues, and their edges are probably curved outwards. Eelworms are also present in the bulbous stems, though not in such numbers as in the inner leaves. They materially damage the plants, and quite prevent the production of grain-bearing stems.

Oat plants frequently sustain serious injury from this eelworm. Their stems are short, yield little or no corn, and become "tulip-rooted." In a bad attack the roots become shortened, contorted, and light in colour, and are evidently of little use to the plants. The edges of the leaves are twisted outwards in a peculiar fashion.

Rye does not appear to suffer much in this country from this eelworm, though in France and Germany it is often seriously injured. Barley does not seem to be attacked.

Beans are occasionally infested, when the lower parts of the plants become swollen, and growth is stayed.

Onion plants infested by eelworms in the early stage of their growth have swollen and twisted leaves, in which eelworms may be found in large numbers. When the bulb is more advanced, it swells unnaturally in the upper part, and becomes soft and pulpy. It splits open, the outer folds fall away, and the whole bulb soon decays. In the growing

parts of the bulbs eelworms are found in numbers in all stages of existence, but not in the decayed parts.

Hyacinths and other flower bulbs are affected by this eelworm in the same manner as onions.

Some roots of hop plants which had become "nettleheaded," as hop-planters say, and of which the growth was arrested, —while the bines slipped down the poles and the leaves became distorted—were examined, and considerable numbers of *Tylenchus devastatrix* were found in them.

Some grasses and other wild plants are also infested by eelworms, amongst these being Yorkshire fog, sweet-scented vernal, annual meadow grass, daisy, shepherd's purse, spurrey, buttercup, cornflower, sow thistle, climbing buckwheat, and lance-leaved plantain.

The roots of cucumbers and tomatoes are not infrequently found to be much swollen and covered with outgrowths, which are due to the attack of an eelworm, of, however, a different genus (*Heterodera radicicola*) to that at present under consideration, while *Heterodera schactii* infests beet, hops, and several crucifers.

Life History.

The full-grown eelworm (*Tylenchus devastatrix*) is about the twenty-fifth of an inch long. Its length varies somewhat in different plants. In appearance it resembles a tiny eel, with both ends pointed, the hind end specially so. It has a sharp spear-shaped point within the gullet (seen under a high magnification), which serves to pierce the tissues of plants and to extract their juices. The eggs are oval, and sometimes oblong in shape, as shown in the figure, and are found in the tissues of the host-plants, together with partly grown and fully developed eelworms. When the young worms come from the eggs, they are about one-seventh of the size of the adult eelworm, and resemble them in outward appearance, though their internal parts differ somewhat. The young form undergoes several changes or moults, before it becomes a perfect eelworm. When the tissues of the host-plant decay and dry up, the eelworms and the young forms either fall to the ground and enter it, or the eggs and young worms remain in the decaying and dead parts, and become dried up with them. Eggs containing the embryo worm can be kept dry for six months without losing their power of hatching, and young worms have the power of resuming animation and active life after they have remained in a perfectly dry condition, in dead tissues or in dry soil, for between two and three years. It is apparent that this faculty enormously increases the chances of the distribution and spread of this nematode, which may be carried into fields and gardens in this dried-up state with manure made from infested hay or straw—in these days cut very close to the ground.

Methods of Prevention and Remedy.

1. It may be said at once that this pest is extremely difficult to deal with, but the following points should be attended to. A rotation should be selected that will allow as long an interval as possible to elapse between the growth of two crops of the same species. Red clover, for instance, suffers severely on many farms if cultivated on the four-course rotation, whereas it remains comparatively healthy if the interval between two clover crops is extended to six or eight years. Onions also, in many cases, can only be successfully grown with a long interval between the crops.

2. As far as possible the refuse of infested crops should be destroyed. This may be most economically done by composting with lime.

3. Deep ploughing, with the use of a skim coulter, is an excellent preventive practice, not only against this pest, but also against many others, including insects and weeds. In garden cultivation trenching, so as to bury the top spit thoroughly, takes the place of deep ploughing.

4. Suitable manuring and cultivation, so as to produce vigorous plants, are general methods of prevention that no cultivator should neglect. Information with regard to certain points connected with manures will be found in Leaflet No. 72.

5. Several of the late Miss Ormerod's Annual Reports contain notes on eelworm infestation, and in the 1897 Report various dressings are quoted as having been useful, *e.g.*, "sulphate of potash at the rate of 1 cwt. per acre stopped disease in tulip-rooted oats." Again, in an experiment at Rothamsted on an eelworm infested clover field "a mixture of sulphate of potash 3 cwt., and sulphate of ammonia 1 cwt., per acre, was applied on April 3rd ; the disease ceased and the clover made a very vigorous growth."

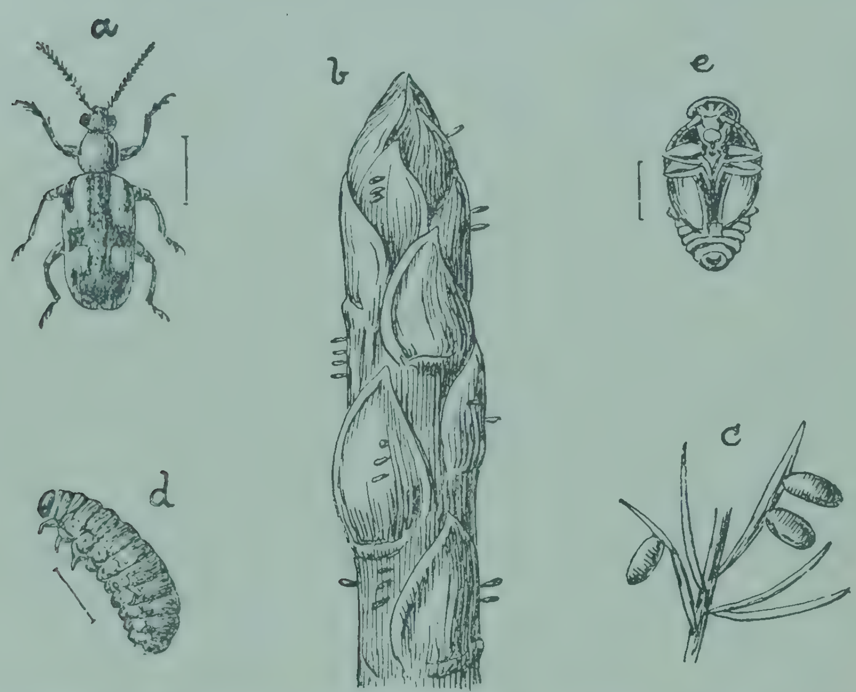
4, Whitehall Place, S.W.,
April, 1898.

Revised, January, 1905.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

The Asparagus Beetle (*Crioceris asparagi*).



a. Beetle enlarged, with line showing nat. size ; *b.* eggs on shoot (nat. size) ; *c.* eggs on foliage enlarged ; *d.* larva, and *e.* pupa enlarged, with lines showing nat. size.

Damage done.

This beetle now and then does harm to asparagus, especially in beds which have been established from one to three years, by eating and disfiguring the heads as they are formed, but chiefly at a later date by attacking the stems, which they particularly relish. In the larval and adult stages the insects bite the tender asparagus heads, making brown patches upon them ; the adults defile the heads with masses of the sticky eggs ; the heads get covered with a brown-black sticky fluid emitted by the larvæ; and thus the appearance of the plants is spoilt for the market. Later on the beetles and larvæ eat the large round seeds, to which they are very partial. Plants may be completely denuded of their foliage by a succession of broods of larvæ. The adult beetles now and then gnaw the shoots underground, and cause them to become bent and woody.

Distribution.

The Asparagus Beetle is locally common in the southern and eastern parts of England, but is rarely found in the northern districts. Canon Fowler, in his Coleoptera of the British Isles, states that he does not know of a record from any locality farther north than South Derbyshire. Enquiries made in 1899 failed to show its presence in the North of England or in Scotland. It is fairly widely distributed around London, and has been recorded as doing damage in Gloucestershire and Warwickshire. While common in parts of Kent, it is rare in Dorsetshire and the western counties. It is known in France, Germany, and Italy, and probably throughout Europe.

Description.

Beetle.—The beetle (*a*) is one-fifth to a quarter of an inch long. It is slender and graceful in form. Its body is shiny black, with a blue tinge; its head is black; its antennæ are dark brown; its thorax is red, with two or three black marks or lines upon it. The outer margins of the wing-cases are of a pale yellow colour, and the inner margins black. There is a transverse bar of black across the wing-cases, upon each of which there are three yellowish or lemon-yellowish spots, or patches, which, with the transverse bar and the black margins, form the figure of a cross; hence the beetle is termed "Cross-bearer" (*Crioceris*). These markings are very variable; sometimes the yellow spots are very small, at others very large.

Eggs.—The somewhat spindle-shaped eggs (*b* and *c*) are brown to dusky greenish-brown, and oval, being glued by their ends to the plants, usually in rows of three to five. Frequently, however, they are placed singly, and occasionally in rows up to eight in number. They are usually covered with a thin gummy coat, and are about one-sixteenth of an inch long.

Larva.—When full-fed the larva (*d*) is from two-fifths to nearly half an inch in length; in colour it varies very much from dirty greenish-grey to dull slate, some grubs being almost yellow; the skin is wrinkled, and the head is black. Each of the first three segments is provided with a pair of jointed feet; the tail segment bears a distinct proleg; and the remaining segments are each provided with a pair of fleshy tubercles.

Pupa.—The pupa (*e*) is pale yellowish in colour.

Life History.

Eggs are laid from June onwards, first upon the heads and shoots, and later upon the feathery foliage of the asparagus plants. The eggs hatch in from 5 to 7 days (Chittenden, writing of America, says 3 to 8 days), and the larvæ at once begin to feed on the asparagus. The larvæ

hold very firmly to the plant by their tubercles and anal proleg. Probably in the course of their growth they moult three times. The larva is full grown in 10 to 13 days, and pupation takes place just under the surface of the soil, in a cocoon formed of frothy saliva which hardens into a case of parchment-like consistency. The cocoon is dull yellow in colour, and grains of earth cover it externally. Lintner says that instead of going into the soil some larvæ "merely conceal themselves beneath dead leaves and other material on the surface."

In Great Britain the pupal stage lasts from 14 to 20 days, but the beetle is mature three or four days before its appearance above ground.

The number of broods depends on the weather; in some seasons there are 3, in others only 2 broods. Adults and larvæ are frequently found upon the plants right into October.

The adult beetle hibernates in the earth, under stones, sticks, and rubbish generally, and also under the bark of trees and in hollow stalks.

Effect of Weather on the Eggs, Larvæ, and Adults.

During warm weather the beetles breed more rapidly; in hot, dry weather, however, many eggs shrivel up, and the larvæ often fail to reach maturity, a long period of such weather materially affecting the increase of the pest. Very cold winters also affect the hibernating beetles, numbers apparently being killed, particularly if warm and cold spells of weather alternate.

An Allied Species.

A closely-related species—the Twelve-spotted Asparagus Beetle (*Crioceris duodecim-punctata*, Linn.), is also found on asparagus in Europe and America, the larvæ living on the foliage and in the berries. In colour it is orange-red, each wing-case having six round black spots. It is apparently very rare, if not extinct, in Great Britain. As it is more troublesome than the common Asparagus Beetle a look-out should be kept for it by growers in this country.

Natural Enemies.

A few natural enemies help to keep down an excess of this beetle. The most important is the Two-spotted Lady Bird (*Adalia bipunctata*), whose larvæ ("niggers") devour the eggs of the beetle. The adults have also been observed to eat them. Larvæ of the Lace Wing Flies (*Chrysopidæ*)—very ravenous Green Fly eaters—also attack the larvæ of the Asparagus Beetle

Methods of Prevention, and Remedies.

1.—In the first stages of this attack, that is, when the beetles are feeding upon the juicy parts of the heads of the asparagus as they are formed, they are difficult to deal with, though at this period they do considerable harm by making the heads brown and spotty. It is desirable to leave a few heads uncut in every bed where there is infestation, as traps for the beetles, which get up the feathery shoots and branches during the day for pairing and the deposition of eggs. In the course of eight or nine days these plants should be cut off close to the ground, and burnt. Another set of heads should be allowed to run to shoots, which should also be similarly disposed of. In America a method among prominent growers is to cut down all asparagus plants in early spring so as to force the parent beetles to lay their eggs upon new shoots, which are then cut every few days before the eggs have time to hatch.

2.—Beds of young asparagus plants are most liable to this attack in the first year or two, when only the strongest heads are cut for market, as the beetles like the succulent shoots of young plants. It would seriously injure the stocks in *newly-made* infested beds to cut off their shoots. In such cases, it would be better to handpick the beds, killing the grubs and eggs between the fingers.

3.—Very finely powdered lime dusted on infested plants would also be efficacious, as it would adhere to the slimy bodies of the larvæ. The lime should be applied as soon as the larvæ are noticed, and the application repeated at intervals.

4.—In extensive beds the remedies to be employed are liming and trapping, as indicated above, by letting some heads grow into shoots and burning them.

5.—Syringing can be adopted in gardens. Where asparagus is grown upon a large scale this process is more difficult, as the plants are not always set in rows, but it may be effected by means of knapsack spraying machines. Paraffin emulsion, consisting of two gallons of paraffin oil, and half a pound of soft soap dissolved in a gallon of soft water, may be used for spraying purposes. The soap should be boiled, and while boiling the paraffin should be poured into it and churned up with the soap until it is thoroughly incorporated. The mixture should then be diluted with fifteen to twenty gallons of soft water.

6.—Paris green is also a valuable remedy against these and other insects which feed upon foliage. It may be used at the rate of one pound of Blundell's Paris green to 200 gallons of water. This mixture can also be put on in a very fine spray. The mixture must be kept constantly stirred. *As this is poisonous, it should not be used till the asparagus has all been cut.*

Spraying should be carried out before the foliage has become thick and strong. It may be necessary to repeat this operation, and it would be effective against both beetles and larvæ.

7.—The asparagus may be sprayed with arsenate of lead, made by dissolving 1 oz. pure arsenate of soda in a little water, dissolving 3 ozs. acetate of lead also in a little water, and pouring both into 10 or 12 gallons of soft water, finally stirring in 1 lb. of treacle.

8.—Poultry and ducks do not seem to eat asparagus, but they readily devour grubs; a few kept in the gardens, especially ducks, would probably do much good.

9.—It would be desirable to examine the roots of asparagus obtained for making new beds, as the pupæ or beetles may be conveyed in these. In the United States infestation is extended partly in this way.

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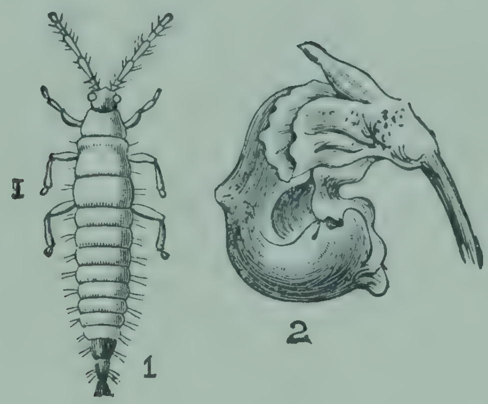
BOARD OF AGRICULTURE AND FISHERIES.

Pea and Bean Thrips, or Black Fly (*Thrips pisivora*).



1. Thrips, much magnified; line showing natural size.
2. Distorted pod.

Complaints are sometimes made of the damage caused by the small insects, popularly called Black Fly Thrips or Thunder Fly, to peas and beans. In 1897 pea plants infested with a species of Thrips were sent to the Board from Kent. Both field and garden peas were attacked. In August 1900 scarlet-runner beans were seriously damaged by these insects in the neighbourhood of Crawley, Sussex. The species of Thrips attacking peas, beans, and other leguminous plants in this country is not definitely established. A great number of kinds exist, some attack wheat, others onions, others are serious pests under glass; damage has been reported to apples; others are carnivorous in habits. In their adult stage they have normally four narrow wings, more or less fringed all round; specimens seldom reach more than $\frac{1}{10}$ of an inch in length. The mouth is formed partly for biting and partly for suction. The six legs are very short, and end in a bladder-like expansion with hooks at the side. Like the Plant Lice they undergo an incomplete metamorphosis; that is, there is no quiescent chrysalis stage.

Damage caused by Thrips.

In the case of attack on leguminous plants, the damage is done almost entirely to the blossom; the pods are thus checked in development. The haulm in cases reported has always been fully developed, but flowers and perfect pods were practically all destroyed. The 'black-fly' by sucking away the sap of the delicate blossoms causes the petals to shrivel up, and the flowers eventually fall off, leaving the stalks behind. In both the attack on peas, reported to the Board, and that on scarlet-runner beans in Sussex, an occasional pod developed, always stunted, however, and more or less distorted and discoloured by the punctures of the Thrips. The plants in both cases looked perfectly healthy and had a good show of blossom promising a good yield, but were practically all destroyed by these insects, which, although insignificant in size, are capable of doing an immense amount of mischief.

In the attack on beans it was noticed that the lower petals of the blossoms were the first to show signs of shrivelling up, then the upper gradually died away, until a little shrivelled mass only remained.

Description and Life History.

The Thrips may be found in all stages inside the blossoms. The adult female is about $\frac{1}{16}$th to $\frac{1}{12}$th of an inch long, deep blackish-brown with paler head and six rather paler bands on the abdomen. There are four narrow wings which are folded over the abdomen in repose; these are densely edged with fine hairs. The antennæ are yellowish-brown with the two basal joints deep brown. The females appear in spring, and like most Thripidæ seem to feed on a variety of plants. As soon as the peas or beans come to the flowering stage the females lay their eggs in the folds of the unopened blossoms. The small eggs may be found loose in the flowers, and hatch out in from eight to ten days. The larvæ are orange in hue, without any traces of wings, and are very active. The larval stage apparently lasts from three to four weeks. The nymph is very similar to the larva in form, but is much paler in hue and shows traces of the wings, in the form of wing-buds. This stage lasts from five to ten days. One or more generations may occur amongst the Thripidæ in the year. No males could be detected amongst those attacking the beans. In all recent cases of Thrips on Leguminosæ the females have been winged, and no males have been observed. In most Thrips the females are winged and the males may be winged or wingless.

The winter is passed in the adult stage, the insects hibernating under the rough bark of trees, in crevices and under any rough bark on the pea and bean sticks, as also amongst the rough herbage at the foot of hedgerows, etc., from whence they come out in the spring and feed on the leaves of various plants.

Prevention and Remedies.

As far as possible all likely winter shelter should be destroyed. Old sticks used for scarlet-runner beans or peas are sure to harbour Thrips. They, and the haulm, should be burnt as soon as possible when the crop is seen to be irreparably damaged. It would certainly be advisable not to grow peas or beans the following year anywhere near where the infested crop had been. Spraying might do some good, but in the case of blossom attacks is a doubtful method. For leaf-destroying Thrips there is nothing like *pyrethrum* wash, formed by adding 1 ounce of fresh *pyrethrum* to 2 gallons of soft water and an ounce of soft soap. In garden cultivation this might be tried as an experiment for this particular species. Liming the ground, and destroying their shelter by burning sticks and haulm as soon as possible, seems all that can be done on a large scale.

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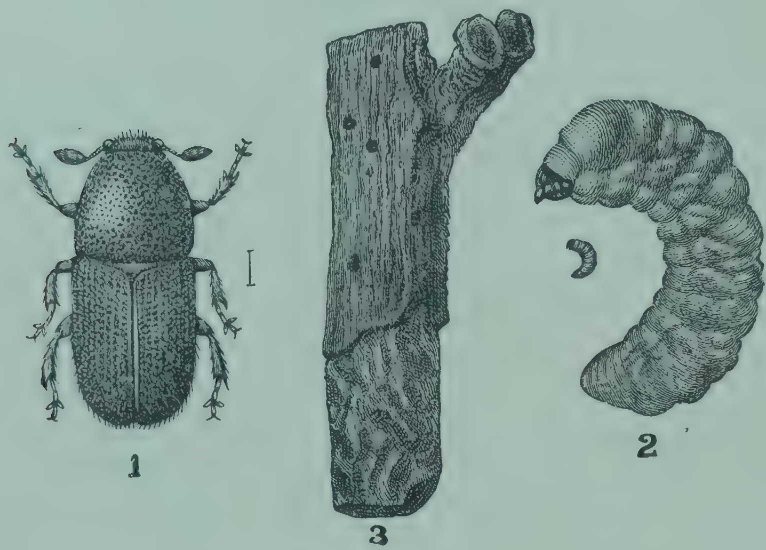
Leaflet No. 49.

BOARD OF AGRICULTURE AND FISHERIES.

The Fruit Tree Beetle (*Scolytus rugulosus*, Ratzeburg).



1. Beetle magnified ; line showing natural length.
2. Larva, natural size, and much magnified.
3. Piece of Apple branch, showing holes in bark made by the beetle, and channels made in the wood.

There have been numerous complaints of damage to fruit trees which on investigation has proved to be due to *Scolytus rugulosus*, the adults and the larvæ of which make tunnels, typically between the wood and the bark. The main stem may be infested, as well as the thicker branches and smaller twigs. If the part attacked has thick bark then the tunnels may be more in the bark than on the wood, but thin-barked branches are commonly attacked, and in such places the tunnels are cut sharply into the outermost youngest wood. The "mother galleries" run in the longitudinal direction and the "larval galleries" are more or less at right angles to these.

Scolytus rugulosus very willingly attacks sickly trees ; the larvæ have been frequently found at work in the tips of shoots of trees injured by frost or other weather influences, as well as near knots and scars from canker or knife cuts. The beetle, however, also attacks healthy trees, and if in overwhelming numbers may kill them.

Trees attacked.—The Fruit Tree Beetle attacks apple, pear, plum, cherry, apricot, nectarine, peach, quince, bird-cherry hawthorn, and mountain-ash.

Signs of Infestation.—External signs of infestation are, the withering and dying of the leaves, exudation of gum from such trees as cherry and plum, the dying away of the ends of twigs and smaller branches, loosening of the bark, the tiny entrance holes which may be obscured by exuded sap, and later the flight holes in the bark through which the new adults have issued.

Description of Insects.

The beetle, which measures one-tenth of an inch in length, is slightly shiny, and pitch-black in colour, the antennae, shanks, feet, and the ends of the wing-covers being reddish brown. The thorax, which is longer than broad, is somewhat narrowed in front and is thickly beset with deep punctures which run together, especially in front and at the sides, and give a wrinkled or puckered appearance. The wing-covers, narrowed behind, are striated and finely puckered, and bear small bristles. The abdomen is arched and slopes from the lower surface, at the hind end.

The larva is a white legless grub, with a wrinkled body, yellowish head, and brown mandibles; the front part of the body is thicker than the hind part.

The pupa is white.

Life History.

The adult beetles bore into the bark, and the female tunnels a gallery in the longitudinal direction, laying eggs right and left, and close together, as she goes along. The length of this "mother gallery" varies from half-an-inch to just over an inch. The larvæ on hatching eat out galleries more or less at right angles to the mother gallery; the regularity of the larval galleries varies according to the number of larvæ present, irregularity being more pronounced if the larvæ are overcrowded. Where there is room, and the branch attacked is thick enough, the larval galleries are regular; only at the top and bottom of the mother gallery the larval galleries bend round to run somewhat in the longitudinal direction. When full grown the larva gnaws out a bed, typically in the outermost wood, and here pupation takes place.

There may be such overlapping in the generations that all stages—larva, pupa, and adult—may be found at the same time. The earliest beetles begin working towards the end of April and in May, and a brood from the eggs laid by these may begin to issue towards the end of June. From the earliest laid eggs of the June beetles new adults may appear in the autumn.

Treatment.

1.—Pruned branches should not be left in heaps to act as centres for breeding.

2.—Infested branches should be cut off and burned by the beginning of June before the new brood has escaped. Badly infested trees should be cut down and burned.

3.—In orchards, plantations, and gardens where there is considerable infestation, worthless trees that are unfruitful or decaying could be ringed and allowed to stand as traps; beetles would choose these for their egg-laying, and the trap trees should be cut down and burned with the enclosed brood.

4.—In the literature referring to *S. destructor* it is recommended that the trees should have applied to them dressings which would deter the beetles from boring. As, however, the thinner branches are attacked by this beetle the whole tree would need to be so treated, and where the trees are numerous such treatment would be scarcely practicable. Soft soap with the addition of a strong solution of washing soda has been recommended for the purpose, the coating of this material on drying being a preventative against the boring of the beetles; lime-sulphur in spring has been recommended for the same purpose.

The beetle is destructive to fruit trees in the United States and several European countries. In the United States several parasites (*Chalcididae*) help to keep the beetle in check; one of these has been identified as *Chiropachys colon* and another was probably *Pteromalus maculatus*. From some Scolytus larvæ sent to the Board of Agriculture and kept in suitable conditions, at least two species of *Chalcididae* appeared.

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BOARD OF AGRICULTURE AND FISHERIES.

Water Wagtails, or "Dish-washers."

(*Motacillæ.*)

There are five species of Wagtails found in this country. Of these only three are fairly common—the Pied Wagtail (*Motacilla lugubris*, Temminck), the Grey Wagtail (*Motacilla melanope*, Pallas), and the Yellow Wagtail (*Motacilla raii*, Bonaparte). The other two, the White Wagtail (*Motacilla alba*, L.) and the Blue-headed Wagtail (*Motacilla flava*, L.), are comparatively rare in Great Britain. Few species of birds are more useful—within the limits of their numbers—than Wagtails, because their food is for the most part of a "soft" character, comprising insects of all kinds and in all stages, and small snails and slugs. The seeds of weed plants may be taken when insect food is scarce. For this reason alone, apart from their beauty and their harmlessness to crops, they and their eggs deserve to be protected. They did not figure in the original schedules of the Wild Birds' Protection Act of 1880; but in several counties in England, Wales, and Scotland some of the species were added to the schedule later.

The Pied Wagtail.

Distribution.—The Pied Wagtail (*Motacilla lugubris*) is perhaps the most common of the Wagtails. It migrates from the more northern to the southern parts of the kingdom in the autumn, some of the birds leaving this country for the winter. Flocks of Pied Wagtails have been noticed in Kent and Sussex near the coast in September, evidently bound for foreign climes. These return again very early in the spring, but there are always Pied Wagtails to be seen throughout the winter in this country, except in the more northern regions.

Description and Nesting Habits.—The male of this species of Wagtail is rather more than 7 inches in length, and the female is slightly over 6 inches long, from beak to tip of tail. The body is black above, while the breast, belly, and parts under the tail are white (*see* Plate). There are also white feathers on the margins of the wings and tail, but the legs and beak are black. The throat is black in summer, but becomes white in winter.

Breeding begins in the spring, and there are often two broods in the season. The nest is constructed of moss, dried grass, bents, and fine roots, and lined with wool, feathers, and other soft materials. From four to six eggs are laid, of which the ground colour is bluish white, with brownish or purple-brown specks.

Food Habits.—The Pied Wagtail may generally be seen in meadows, pastures and fields where cattle and sheep are

grazing, busily engaged in catching the insects attracted by these animals. Gilbert White says: "Wagtails run round cattle, availing themselves of the flies that settle on their legs, and probably finding worms and larvæ roused by the trampling of their feet." "Interest," he adds, "makes strange friendships." This bird is also seen near ponds, streams and rivers, and in marshes and flooded meadows, taking the insects found there. If Pied Wagtails are watched, it will be seen that they are never still, but are continually hunting for insects of all descriptions: beetles, flies, moths, and aphides, as well as millipedes, snails and slugs. They also diligently follow the plough in search of food, and doubtless then account for large numbers of insect pests.

The Grey Wagtail.

Distribution.—This species is not so abundant as the Pied Wagtail. It is of more solitary habits, and is found chiefly in the mountainous and hilly districts of England and Scotland. It frequently breeds, however, in Devon, Dorset, Somerset, and Wilts, and in localities generally where there are streams and brooks, and plenty of water; but less frequently in the south-eastern districts. It is fairly common in Ireland. It migrates to the more southern counties in the autumn.

Description and Nesting Habits.—The Grey Wagtail (*Motacilla melanope*) is not quite so large as the Pied Wagtail. In colour it is blue-grey or slate, with a line of white above the eyes. In summer it has a black chin and throat; the breast, belly, and underside of the tail are yellow; the beak and feet are black. Yellow is such a prominent colour in the Grey Wagtail that its name scarcely seems appropriate, and it is, on this account, apt to be confused with the species described below.

It builds early in the spring, generally in banks, a nest lined with hair, much like that of the Pied Wagtail, and lays five eggs as a rule, though sometimes as many as seven have been seen. The eggs are of a creamy white colour, speckled with light brown blotches, and marked with a few black hair streaks.

Food Habits.—Like the Pied Wagtail, this species subsists almost entirely upon insects, and may be seen, especially near brooks and other water-courses and in marshes, busily hunting for its food. It is addicted also to small fresh-water molluscs, and this predilection doubtless enables it to do good service to sheep farmers and breeders by destroying quantities of the snail known as *Limnœa truncatula*, which is the host of that scourge of flocks, the liver-fluke (*Distoma hepaticum*, L.). Species of *Limnœa* have been found in the crops of all the three Wagtails commonly met with. It was not actually ascertained that the snails were *Limnœa truncatula*, but there can be no doubt that

if these birds feed upon one species of *Limnœa*, they would also feed upon *Limnœa truncatula*, a small thin-shelled snail coming from water-courses and wet ditches to marsh pastures and low-lying grass-land.

The Yellow Wagtail.

Distribution.—The Yellow Wagtail is not a winter resident in this country, but appears in April, and leaves in

THE PIED WAGTAIL (*Motacilla lugubris*).

September and October. It may, however, occasionally remain later, and the Board were informed in December, 1904, that Yellow Wagtails had been observed in two places

near Paignton (Devon), on Dec. 6th of that year. The species is distributed throughout England generally, but is not common in Scotland, except in the more southern counties, whilst in Ireland it is rarely seen. On the first arrival of the immigrants they are found in marshes and grass land, but soon pair and go to the cultivated fields.

Description and Nesting Habits.—The Yellow Wagtail (*Motacilla raii*), as its name implies, is mainly of a yellow or canary colour. The upper parts of the bird are olive, or greenish yellow, and the lower parts more of a canary yellow. The plumage of the female is not so bright as that of the male; the bill and feet are black. In length it is about 6½ inches. The nest, usually placed on the ground in grass or tufts, and occasionally on a bank, is composed of dried bents and fine roots, with dried grass and wool, or hair, or even fine roots, for a lining. Nests are sometimes found upon ploughed land. Two broods are sometimes produced in a season. From four to six eggs are laid; they are greyish-white, mottled with clay-brown, with a few black hair streaks.

Food Habits.—In cultivated fields this species may be seen hunting for insects and following the plough with assiduity, swallowing millipedes, wireworms, and other insects as they are turned up. Breeding begins early, and after the young are hatched, the birds move off to meadows, marshes, and pastures, where they follow cattle and sheep for the insects around them, and may be seen busily hunting for all kinds of insects, upon which they live. Like all the Wagtails or Dish-washers, they are constantly found near water-courses, ponds, and marshy places. There is no doubt that this Wagtail, like its congeners, devours the snail-hosts of the liver-fluke.

From this short account of Wagtails it will be seen that these birds are of very great economic value, and should everywhere be carefully protected.

4, Whitehall Place, S.W.
October, 1898.

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Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 11 *leaflets dealing with Wild Animals and Birds may be obtained from the same address. Price* 1*d., post free.*

BOARD OF AGRICULTURE AND FISHERIES

The Barn Owl (*Strix flammea*, Linn.).

The Barn, White, Screech, or Church Owl, as it has been variously called, is beyond question a most useful bird, and yet it has been much persecuted.

The destruction of this bird has been due to a variety of reasons : to superstition (associated with the bird's being a night flier, and having a noiseless flight and a weird cry) ; to faulty observation and ignorance of its true food habits ; to the price obtainable for its eggs ; to the demand for the bird by bird-stuffers ; and to the use of its plumage for decorative purposes.

There is some ground for the belief that even with game-keepers the Barn Owl is not so ruthlessly destroyed as formerly, the statement that the chief food of the owl consisted of game birds having been disproved. The Barn Owl (like other birds of prey) has the habit of disgorging by way of the mouth indigestible particles, in the form of pellets, and by examination of these one can determine on what the bird has been feeding. Dissection and examination by competent and unprejudiced observers of numbers of the disgorged pellets, has proved that fur and not feather is the chief food.

Description.

The Barn Owl has the characteristic curved beak and strong talons of a bird of prey. The colour varies in different specimens ; the upper parts of the adult may be tawny-buff, mottled with grey and white and brown, and the under surface whitish. The upper side may, however, be more grey than brown, and the under side yellowish with greyish or blackish spots.

The face is white and the bill yellow. Round the eyes and beak the feathers show a heart-shaped pattern. The legs are long and covered with downy feathers. No tufts are present on the head, such as characterise the Long Eared and the Short Eared Owls. The female is rather larger than the male, the length being about 14 inches.

Favourite places for egg-laying are buildings, such as church towers, ruins, or barns, but holes in rocks, and hollow trees in woods are also used. Dovecotes may also be frequented, the owls living on the whole peacefully with the

pigeons. No actual nest is made. The eggs are white, and the number laid may be up to six or seven. Incubation begins, however, after, say, two have been laid, other eggs being laid at different periods during incubations, so that it is possible to find in the nesting place unhatched eggs and young of different ages.

The Barn Owl has a wide distribution.

Mode of Life and Food Habits.

During the day the owl stands motionless and asleep in its shelter-place, but at nightfall it sallies out with its stealthy noiseless flight and patrols its beat in the search for food. With its large eyes forwardly directed, the owl's sense of sight during flight is very keen (it cannot, however, see in perfect darkness), but it is equalled if not excelled by its sense of hearing. The ears are covered by folds of skin which are bent forwards during flight. The soft loose plumage enables the bird to fly along noiselessly so that the prey is not alarmed, while the slightest sound or motion of the prey is heard in the stillness, by the owl. The cry of the owl is a weird screech or shriek, and both old birds and owlets make a noise resembling snoring.

The food of the Barn Owl consists chiefly of mice and voles, but rats may be taken and also bats ; the larger insects are taken on occasion and even various small birds, but the percentage of these last is small ; the Barn Owl has been known also to take surface-swimming fish.

Seebohm, in his exhaustive history of British birds, holds that the Barn Owl is undoubtedly the farmer's best friend. He gives an instance in which twenty freshly-killed rats were found in a Barn Owl's nest. He also says that in 700 "pellets" of this owl there were found the remains of sixteen bats, 2,513 mice, one mole, and 22 birds of which nineteen were sparrows.

Lord Lilford writes of a half-grown owl eating nine mice in rapid succession and being hungry again in three hours ; and also of an old pair of owls which brought food to their nest seventeen times in half-an-hour.

Another observer describing the contents of various nesting places of the Barn Owl remarks that he found four species of mice at the same time in one nest : the common farm mouse ; the little white-bellied, red-backed, short-bodied, harvest mouse ; the large, thick-coated, full-headed, short-tailed grass mouse ; and the long, sandy, long-tailed long-eared field mouse.

The Barn Owl will take young hand-reared game birds, but this can easily be prevented by keeping them in their coops at night ; naturally hatched ones are safe under the mother's wings at night.

In the Report of the Departmental Committee of the Board of Agriculture on Field Voles in 1893 it is stated that white and brown owls prey upon these pests, which caused much mischief on hill farms in Scotland; and in

THE BARN OWL (*Strix flammea*).

their two schedules of the natural enemies of the vole the Committee place in the first category of "Vole-killers, harmless or nearly so to sheep, crops, and game," owls of all sorts, buzzards, kestrels, and the smaller seagulls.

In view of the unanimity of evidence as to the great utility of the Barn Owl, from witnesses who have carefully studied its habits, the necessity for the careful preservation of this valuable bird cannot be too strongly urged upon the whole rural community.

The White or Barn Owl is included in the Schedule of the Wild Birds' Protection Act, 1880, which provides that any person taking or killing an Owl during the close season is liable to a penalty of £1. The close season is generally from the 1st March to the 31st July; but in some counties it lasts from the 1st February to the 31st August. The eggs of the Barn Owl are protected in a large number of counties.

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6084

BOARD OF AGRICULTURE AND FISHERIES.

The European Gooseberry Mildew.

(*Microsphaera grossulariae*, Lév.)

There are two kinds of mildew which attack gooseberry bushes, but which, though they appear to the naked eye to be very much alike, and are liable to be confused by careless or incompetent observers, are nevertheless found to present very great differences under the microscope. The two pests are known by the common names of European Gooseberry Mildew and American Gooseberry Mildew.* The former species, *Microsphaera grossulariae*, has been known in this country for many years. As a rule it attacks only the leaves, and is very seldom found on the fruit, and then merely on the tip. The American gooseberry mildew (*Sphærotheca Mors uvæ*, Berk.), on the other hand, attacks not only the leaves but the young shoots and the fruit, covering them in the summer with a glistening woolly surface, which changes in the autumn and winter to a brown felted mat. The two species of fungus may appear on a plant at the same time.

The European mildew (Fig. 1) often appears when a warm moist spell of spring weather is followed by a sudden lowering of the temperature.

The white powdery form in which it is seen is caused by myriads of spores of the summer fruit of the fungus; these spores unless destroyed are blown about by wind and infect neighbouring bushes.

Later on in the season a second form of fruit resembling minute black points, just visible to the naked eye, appears on the mildewed patches. This second form of fruit ripens on the dead fallen leaves during the winter, and infects the young leaves the following spring.

When the disease is severe the leaves die and fall off early in the season; the fruit is thus checked in growth and remains small. If the epidemic occurs for some years in succession the bushes become stunted in growth or may even be killed.

* The American Gooseberry Mildew is fully described in Leaflet No. 195.

1. Gooseberry Mildew; 2 & 3. American Gooseberry Mildew.

Treatment.

1.—Although this disease is not of so serious a character as the American gooseberry mildew (Figs. 2 and 3) it should be treated in the same way. A solution of liver of sulphur in the proportion of 1 lb. to 32 gallons of water should be sprayed over the affected bushes with a mist-forming sprayer, the spraying being repeated as occasion demands.

2.—All dead and fallen leaves should be collected and burned and the ground should be dug so as to bury effectively any fungus fruit lying on the ground.

3.—Kainit may be usefully employed as a manure.

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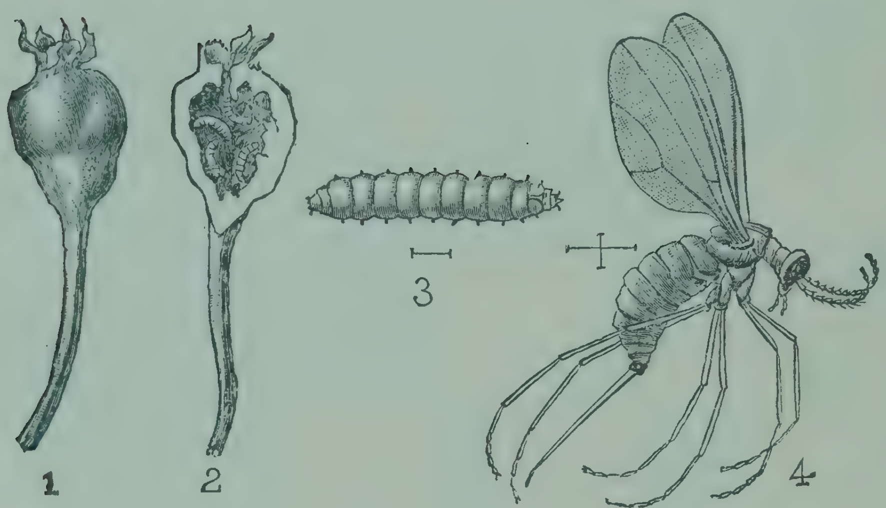
Leaflet No. 53.

BOARD OF AGRICULTURE AND FISHERIES.

The Pear Midge.

(*Diplosis pyrivora.*)



1. Pear stunted and malformed by the larvæ within it. 2. Section of pear with larvæ. 3. Larva, much magnified. 4. Female fly, much magnified. Lines show natural length of fly and larva.

The pear midge causes serious losses in pear orchards by its attacks on the young fruit. Some pear growers, seeing the young pears falling fast in June when they are about the size of marbles, used to believe that this result was due to an unhealthy condition of the tree, or to influences of the weather, but they now recognise that it is more often due to the insidious attack of the tiny pear midge, the presence of which is far more common than is usually believed.

It would appear that early pears, and those that blossom early, are most liable to infestation by this insect. Williams' Bon Chrétien is notoriously subject to it, and in America, where the pear midge is very prevalent and most destructive, the Bartlett pear (identical with Williams' Bon Chrétien) and the Lawrence are the varieties chiefly attacked. Beurré de l'Assomption, earlier than Williams' Bon Chrétien, is also frequently seriously affected. Pitmaston Duchesse, Marie Louise, Jargonelle, Souvenir du Congrès, all early,

and like the Bon Chrétien in many respects, are also especially liable to be infested. Infestation has been noticed on later pears, as Josephine de Malines and Catillac, but in a much less degree than on earlier varieties.

Professor Riley, writing in 1885, considered that the insect had been imported from Europe, as until it was found in 1880 upon a certain farm near Meriden, in Connecticut, no insect of similar habits was found in the United States.

This is probably the same insect as that termed *Cecidomyia nigra* by Meigen. Schmidberger first described the habits of this insect in 1831. He says: "The species of gall-midges found by me in the pears are evidently the *Cecidomyia nigra*, because the description which Meigen gives of the black gall-midge completely agrees with this. I retain Meigen's name, and call it the black gall-midge." Riley, however, suggested that the name of *Diplosis pyrivora* would be suitable, and this has been adopted by entomologists, as it is not certain that Meigen's species is the same.

It is not known how long the pear midge has been at work in this country. It was first mentioned more than twenty-five years ago, and there is every reason to believe that it had been present here long before this, for its action upon pears, closely resembling, as it does, that of weather and other natural causes, might easily have been mistaken for these, especially as there were then comparatively few trained observers. It is certainly on the increase in many parts of the country, causing a heavy annual loss, and unless checked will cripple the cultivation of this fruit.

Description.

The fly is nearly one-tenth of an inch long, with an expanse of wings of nearly one-fifth of an inch. Its slender body is blackish-grey to black in colour, with pale yellowish and white hairs; its antennæ, with twenty-six joints in the male, are dark brown and very long; its legs are also very long, and yellowish brown. The wings are grey with dusky hairs, and a few dull yellowish ones at the base. The female is slightly longer than the male, having antennæ with fourteen joints, and an exceedingly long ovipositor for the purpose of depositing her eggs in the calyces of the blossoms of the pears. In colour the female is dusky grey, always paler than the male.

The larvæ are footless, yellowish-white in colour, and are composed of fourteen segments, with a brown head, bearing two nipple-like, two-jointed antennæ; on the underside near the head end is a long brown process slightly furcate at the tip—the anchor process or breast bone. When mature the larvæ reach one-seventh to one-sixth of an inch in length.

The pupa is about one-tenth of an inch in length, black above, and yellowish-brown beneath.

The eggs are longish, and transparent white, a number being laid in a single flower.

Life History.

The perfect midge appears in April, about the time the blossoms commence to show signs of the white petals, and continues on the wing until about the second week in May. The exact time varies from year to year and in different localities to some slight extent. The females lay their eggs both in the unopened and the expanded blossoms by means of the long egg-laying tube. When the blossom is unopened they pierce the petals and deposit the eggs on the anthers, usually in little heaps. When the blossoms are expanded they push the egg-tube deep into the pistil or ovary. In from four to six days the eggs hatch and the young maggots make their way into the developing fruit. By the first week in June some of the maggots are fully grown and commence to leave the fruit; the majority may be mature by the end of the second week, or towards the end of June the pears may still contain the maggots. Some are however unable to escape owing to the pears not splitting or decaying so rapidly, and thus remain on the trees longer. The majority of the maggots leave the pears, either by a cleft on the fruit or by some decayed patch. The fruit may or may not fall with the maggots in it; as a rule the larvæ escape when the pears are on the trees, but some correspondents mention the ground being covered with small fruit laden with midge larvæ. The maggots, in common with others of the genus *Diplosis*, have the power of skipping. When they leave the fruit on the trees they move to the outer surface, bend their bodies and make a spring on to the ground. At times this jumping habit is very marked. As many as forty larvæ have been counted in a single pear, but fifteen to twenty seems to be about the normal number. In some pears picked at random from infested material the following numbers were found :—16, 21, 28, 15, 19, 15, 17, 23. On reaching the ground the larvæ bury themselves under the soil, usually about an inch and a-half from the surface. Professor Lintner observed them to go as deep as two and a-half inches in America. At the end of about two weeks they have completed little papery cocoons of a dirty creamy silk, which become more or less covered with fine grains of earth. The cocoons are one-tenth of an inch long. Many of the maggots may remain as such until the end of winter and pupate in the early spring; others seem to pupate in a few weeks after entering the soil. If the larvæ cannot escape from the pear, as sometimes happens, they remain in it (as larvæ) for some time, until it decays on the ground.

When the larvæ first attack the fruitlets their presence cannot be detected ; later they form small dark tunnels, and by degrees they hollow out all the pear, which becomes internally a blackened mass of pulp and excreta.

Appearance of Infested Fruit.

About two weeks after the attack has commenced the fruitlets begin to swell abnormally. The diseased fruit always grows much more rapidly than the sound. By degrees the fruitlets become deformed, some rounded, others bulged out at the sides and much distorted. On cutting them open they will be found to contain the larvæ. Internal examination should always be made, as sometimes pears become deformed from other causes.

Preventive Measures.

1.—In gardens the best remedy is hand-picking where dwarf trees are attacked, but in large orchards this is not possible.

2.—Mr. Fletcher, entomologist to the Canadian Government, suggested that when trees are persistently badly attacked and the fruit not likely to come to maturity, a heavy spraying with arsenites or sulphate of copper should be given so as to kill the fruit ; the larvæ would thus all be starved to death by having their food destroyed.

3.—Skimming off two inches of the surface soil beneath the trees in winter and burning it, replacing it afterwards as is done in gooseberry sawfly attack, would be sure to do good, but on a large scale probably could not be carried out. Certainly it is advisable to cultivate the ground beneath the trees, instead of having the land under grass.

4.—At present no detailed experiments have been carried out with spraying, but it is possible that by spraying with paraffin emulsion as soon as the blossoms show the first white petals, and at the same time giving the ground a good drenching with the emulsion beneath the trees, the pest might be deterred from egg laying and many killed in the soil. This would have to be done at the time when the flies are appearing from the soil. The emulsion for the ground should of course be stronger than that applied to the tree.

5.—The use of kainit has proved serviceable in America. Dr. Smith, who has made careful experiments with the pear midge, has found that kainit spread under the trees has been most effectual in killing the larvæ. He recommends that the ground under the trees should be dressed with kainit at the rate of a ton to the acre and mentions an instance of an orchard so treated having practically escaped infestation, while in an adjoining orchard not treated he failed to find a single fruitlet not containing larvæ. In New Brunswick

kainit has also been used with success in orchards at the rate of half a ton to the acre. In Great Britain some experiments (Journal S.E. Agri. Coll., No. 7., p. 27) have shown that kainit at the rate of 5 cwt. to the acre killed the larvæ if applied just about the time the larvæ fall from the fruit, though a Herefordshire grower who employed this method in his orchards got negative results. It is certainly advisable for growers to give kainit a fair trial at the rate of half a ton to the acre, a quantity that may be safely used, where the orchards are down with grass or not cultivated with strawberries or vegetables. To be successful the kainit must be spread very evenly, and be applied just before or when the larvæ are falling, as it has the greatest effect on the larvæ before they become enshrouded in their silken cocoons.

6.—Gas lime has been used but is not successful; its coarse nature enables many of the grubs to escape its effects, but possibly, if finely powdered and spread evenly, it might have a similar effect to kainit.

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BOARD OF AGRICULTURE AND FISHERIES

The Spotted Flycatcher (*Muscicapa grisola*, Linn.).

The spotted Flycatcher, known also in some districts as the "Beam bird" because it sometimes builds its nest on beams in outbuildings, is, as its name signifies, a devourer of insects. It is also known in Northamptonshire as the "Cobweb," and in Kent as the "Cherry sucker." It is a fairly common bird in England and some parts of Ireland, but is not so frequently met with in Scotland. This bird winters in Africa, and of our summer birds appears late, arriving in this country about the beginning of May, Gilbert White dating its arrival between May 10th and May 30th, although Markwick in his calendar gives the dates between the 25th of April and May 22nd. Other naturalists say that it generally appears when the oak is in leaf, which means that the date of its arrival in May depends upon whether the season is backward or forward. Selby says it seldom makes its appearance before the latter part of May, or until the woods are in complete foliage, when the particular insects that compose its food are in full vigour and maturity. Howard Saunders states that it has been observed exceptionally in our eastern counties as early as April 23rd. In Gilbert White's calendar the bird is recorded as departing from these shores between September 6th and September 29th, and these dates agree pretty closely with those given by Markwick and other observers.

Description and Habits.

The spotted Flycatcher is not quite six inches in length from head to tail. The head and back of the bird are of a chestnut-brown colour, while the wings and tail are of a darker brown; the breast and the under parts vary from greyish-white to greyish-brown; the legs and bill are dark brown. On either side, at the base of the bill, there are numerous hair-like pointed projections, or short bristles, which are peculiar to a few species of insectivorous birds, and serve to prevent insects from getting on the bill. The female is slightly smaller than the male, but almost identical in colour.

The spotted Flycatcher constructs its nest of stems of grass, horsehair, moss, lichens, and wool, lining it with feathers, common spots chosen being a hole in a wall or tree, the fork of a tree, beams in outhouses, ledges of rocks, fruit trees nailed to walls, and the stumps of trees. It returns to its old nesting haunts and often avails itself of

the old nests of other birds. The eggs are usually five in number, varying in colour from pale green to bluish-white, mottled with rust-coloured and purple spots. There appear to be two broods in the year.

Food of the Spotted Flycatcher.

The spotted Flycatcher frequents orchards, gardens, plantations and woods, and the banks of streams. It feeds exclusively upon insects, though it has been accused of eating fruit by those who have seen it near cherries and raspberries when in search of insects attracted by ripening fruit. Yarrell states that no remains of fruit were found in the stomachs of Flycatchers which had been suspected of taking fruit, and killed. Selby also observes that he has not been able to verify the alleged fondness of this bird for cherries, and he is inclined to believe that the Garden Warbler, sometimes called the greater Pettichaps (*Sylvia hortensis*) has in most cases been mistaken for the Flycatcher. The Garden Warbler does eat fruit, but there is not the least evidence of the spotted Flycatcher touching cherries or any other fruit, as it is sometimes supposed to do in Kent.

The spotted Flycatcher may often be seen either taking a short sharp flight in search of insects, or, perched on a rail, gate, or branch, making frequent swoops at passing insects and returning to its coign of vantage. Sometimes it half jumps, half flutters, from the ground and snaps up flies, gnats, and other insects within easy reach. It takes all kinds of insects: butterflies, moths, flies, sawflies, beetles, and aphides. During August when the air is thick with aphides coming in swarms from the hop gardens, the Flycatchers appear to be perpetually in motion from their eagerness to devour the winged hosts. Macgillivray says that the food of this bird consists exclusively of insects of various kinds. He gives a description of the feeding of their young by a pair of Flycatchers. The parent birds brought food to the nest five hundred and thirty-seven times during the course of a day. "Their motions," Macgillivray says, "were so uncommonly rapid that I could not for a single moment keep my eye off the nest. By short jerks they usually caught the winged insects. It is impossible to give the precise number of flies that might have been consumed by this brood, as they sometimes brought them one large fly, at other times two, three, four, five, and even more flies of different sizes."

Owing to its extraordinary insectivorous propensities and its perfect harmlessness, this little bird and its eggs ought to be carefully protected, and the birds encouraged to increase in numbers.

4, Whitehall Place, S.W.
January, 1899.
Revised, April, 1908.

THE SPOTTED FLYCATCHER.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of Application so addressed need not be stamped.

Leaflet No. 55.

BOARD OF AGRICULTURE AND FISHERIES.

The Swallow.

(*Hirundo rustica.*)

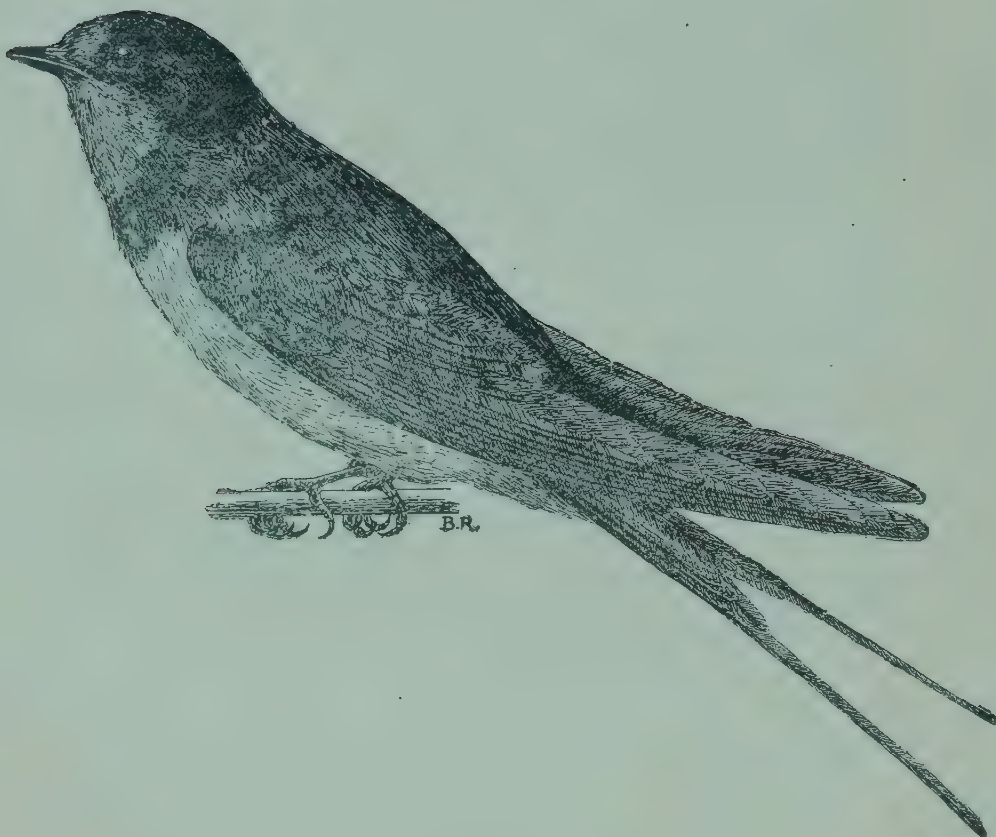

FIG. 1.

Male Swallow. (⅔rds natural size.)

This bird is sometimes called the "Chimney" Swallow, sometimes the "Barn" Swallow. Macgillivray says that the former name is not quite correct, as the Swallow rarely builds in chimneys. He distinguishes it from the Martin (*Chelidon urbica*) by calling the first the "Red-fronted," and the Martin the "White-rumped."

There is considerable confusion between the Swallow and the Martin, and this is accentuated by the similarity in their

habits and their appearance in this country at about the same time. They may be distinguished thus :—

Swallow.	Martin.
Forehead and throat chestnut-brown.	
Upper surface steel blue, including the rump.	Upper surface steel blue except the rump which is white.
Lower surface dusky reddish-white. (The female has lower surface whiter.)	Lower surface white.
Tail markedly forked, with a large white spot on the inner web of all except the middle pair of rectrices. (The female with outer feathers of tail shorter.)	Tail not so markedly forked, uniform in colour. Wings shorter.
Feet and toes not feathered.	Feathers on feet and toes.
Eggs white, speckled with brown or dark red spots.	Eggs pure white.
Nest open at the top.	Nest with a small hole only, for entrance.

The Sand-Martin is smaller than either of these two birds, and its upper surface is brown or mouse-coloured.

The Swallow, the Martin, and their ally the Sand-Martin (*Cotile riparia*), are of great benefit from an economic point of view, as insect-destroyers. They live solely upon insects, which they catch mainly when on the wing, though they may often be seen taking them from the surface of the water, and sometimes from the ground. Swallows take insects of many kinds, although probably their commonest food consists of the various species of two-winged flies. When the large species of *Tipulidæ*, such as *Tipula paludosa*, and other "Daddy Longlegs" or "Crane flies," come from the pupal form towards the end of the summer, and fly heavily over the fields, pastures, and lawns, they are eagerly seized by the Swallows, which fly low to secure them. Swallows have been observed destroying quantities of the "hop flies," or aphides (*Phorodon humuli*), as they leave the hop gardens for their winter quarters on the neighbouring plum and damson trees, from which they come again in the early spring and go to the hop plants. The migrations of these insects afford a fine harvest for Swallows, but unfortunately the latter are now so reduced in numbers that their influence in keeping down "hop flies" is much less effective than formerly. It is said by some observers that the regular

recurrence of hop aphis attacks, known as "blights," year after year, and their alarmingly increasing intensity are due to the absence of Swallows. This increase is, however, more probably due to the plan of planting prunes in the alleys.

In the Swallow (*Hirundo rustica*) the plumage of the head, neck and upperparts, including the wings and tail, is glossy steel-blue, with the forehead and throat chestnut ; the rest of the underparts is whitish-buff ; and all the tail-feathers except the middle pair have a large oval mirror of white on the inner web. The bill is black and the feet brown, or brownish-black. It is about seven inches from the head to the tail, and its wing expanse is fourteen inches. There is but little difference in the appearance of the sexes ; the tail of the female is, however, shorter than that of the male, whilst the underparts are whiter and there is less black on the breast.

This bird appears in our country, as a rule, about the beginning of April, reaching the North of Scotland about the middle of May. Its nest is composed of mud or dirt mixed with bits of straw or dried grass and hair, and is lined with fine grasses and feathers. It is not covered like the Martin's nest, and is placed under the eaves of barns and other buildings, on the beams and joists of out-houses, under gateways, and beneath the arches of bridges. The eggs, of which four or five are usually laid, are white, speckled with brown or dark red and lilac spots. Normally there are two broods. The young of the first brood generally fly towards the end of June, and the second at the end of August.

FIG. 2.
The Martin. (⅔rds natural size.)

About September the birds congregate and betake themselves at night to trees, telegraph wires, &c., to prepare for their long flight to warmer regions in Africa, where they pass the winter. All the Swallows do not leave in the first flight. The young birds may go first and the old birds later, the last flight taking place at the end of September or even in October.

The continued decrease in the numbers of Swallows and Martins is a serious loss to agriculture. It seems that there are two reasons for this diminution, one being the slaughter of the birds in the south of Europe, both for food and for purposes of millinery; the other reason being the disturbance to which they are subjected by the ubiquitous Sparrow, whose numbers have largely increased in late years. The places where Swallows have been accustomed to build are occupied by Sparrows, whose pugnacity and overbearing spirit will not allow any other birds to come near them.

The Swallow is not included in the schedule to the Wild Birds Protection Act of 1880; but a special close time has been prescribed for its protection in certain counties, and its eggs are also protected in several counties.

4, Whitehall Place, S.W.,
January, 1899.

Revised, July, 1912.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, *Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.*

A pamphlet containing 11 *leaflets dealing with Wild Animals and Birds may be obtained from the same address, price* 1*d. each, or* 9*d. per dozen copies, post free.*

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BOARD OF AGRICULTURE AND FISHERIES.

The "Canker" Fungus

(*Nectria ditissima*, Tul.)

The term "canker," as used by fruit growers, is applied to any disease of fruit trees, independent of its origin, where the bark becomes cracked and more or less destroyed. It is, however, very important that the true cause of the canker should be ascertained, otherwise preventive measures cannot be applied with any certainty of success, as the remedy most effective against one particular form of canker may prove useless against another kind of different origin.

The most frequent and at the same time most destructive form of canker attacking apple trees in this country is caused by a minute fungus (*Nectria ditissima*), and as the general appearance of the wounds produced is very well marked no difficulty should be experienced in recognising this particular form.

The fungus can only gain admission to the living portion of a branch through a wound, being unable to pierce the unbroken bark. In the case of slender branches the wounds may be caused by frost, hail, or the punctures of insects. Having once gained an entrance the fungus spreads rapidly in the living bark, which becomes eaten away in irregularly-shaped patches leaving the wood exposed. In some cases the wound is confined to one side of the branch, but in many instances the bark is completely destroyed all round the branch, when the portion above the wound is at once killed. In very young branches the wood is also frequently destroyed as shown in Fig. 1. A very characteristic feature of the disease, when attacking young branches, is the thick rugged mass of bark which forms round the edge of the wound.

On older parts of the tree canker usually first appears in the fork of a branch, access being gained by the fungus through a crack caused by the over weighting of the branch with leaves or fruit. In this case deep, more or less curved, cracks first appear in the bark, which is finally destroyed, leaving irregular patches of naked wood. After becoming well established the fungus travels up the branch in the bark and bursts through to the surface at different points along its course, and by this means the branch is eventually killed.

In addition to the symptoms described for the recognition of true canker the fungus itself may be found if carefully looked for. During the wane of summer patches of minute white specks may be seen nestling in crevices of the rugged bark surrounding the wounds; these are the first form of fruit produced by the fungus. In the spring these white patches produce a second form of fruit consisting of very minute bright red balls. A magnifying glass, which can be purchased for a shilling, greatly assists in detecting these minute bodies, the presence of which settles all doubt as to the cause of the disease.

During the winter months, when the characteristic white fluff has disappeared, the swellings and wounds caused by the American Blight (*Schizoneura lanigera*) somewhat resemble the wounds made by the canker fungus, but careful observation will reveal the presence of the Blight insect in the cracks.

Some kinds of apple tree are more susceptible to the attack of the canker fungus than others. Those which yield some of the best eating apples are most liable to it. Cox's Orange Pippin is a variety subject to this disease, as are also the Ribston Pippin, the Golden Pippin and several of the Rennets or Reinettes, notably Reinette des Carmes. Trees with the thinnest and smoothest bark are most liable.

Pear, plum, oak, beech, ash, hazel, alder, maple and lime trees are also attacked by the canker fungus.

Prevention and Remedies.

Young branches that are attacked should be cut off, as they are certain to to be girdled and killed at an early date.

When thick branches are diseased all the wounded parts should be cut away and the cut surface luted with clay or protected with a coat of gas tar. If the disease has spread from the original point of infection, and appeared at the surface in other places, the branch should be cut off.

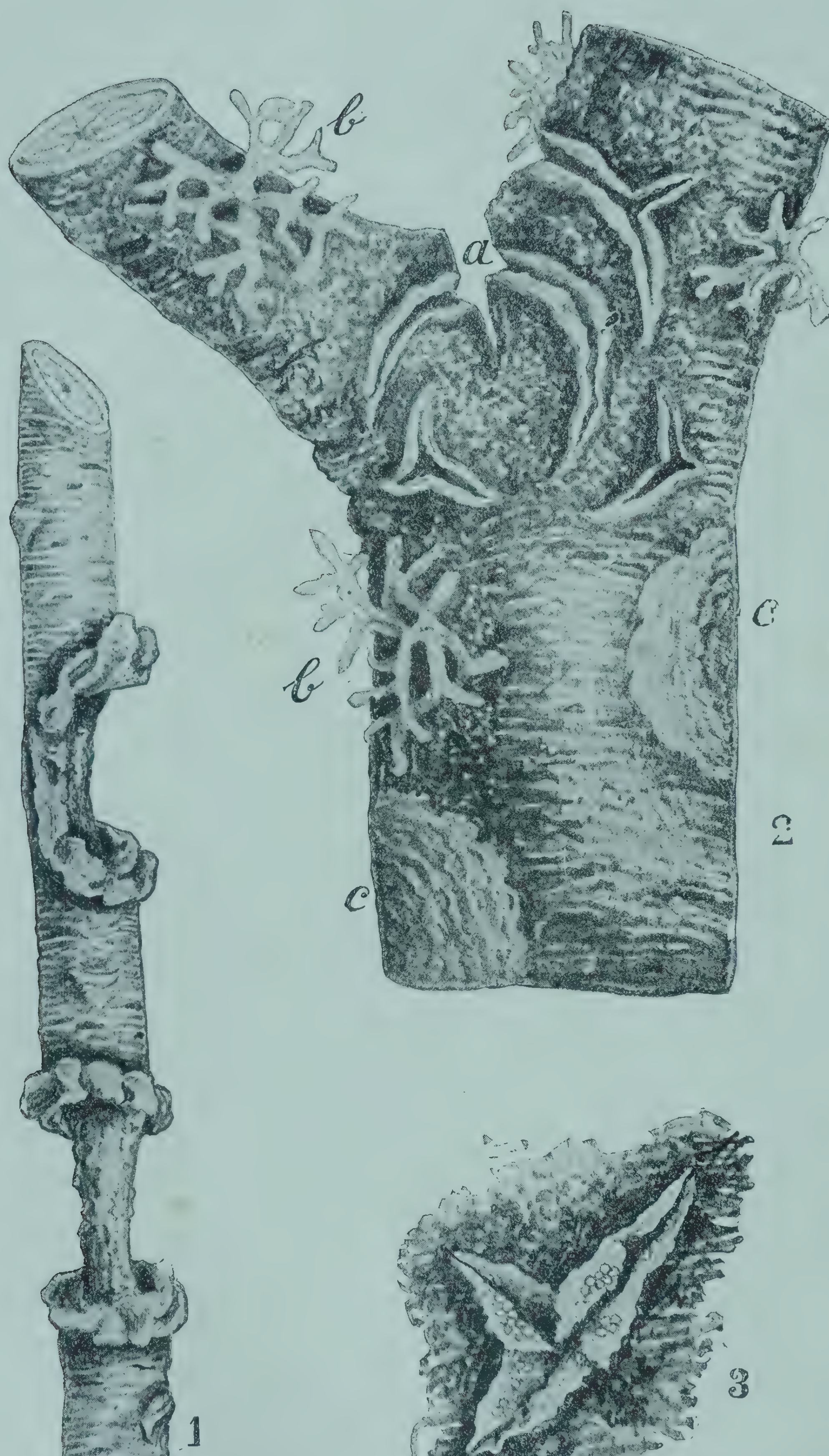
It is very important that grafts should not be taken from diseased trees, as parts that appear to be sound may contain the fungus in their tissues.

The white stage of the fungus can be killed by applying with a brush a solution of sulphate of iron—1 lb. to a gallon of water. This mixture will also destroy lichens and moss growing on the trunk and branches.

Description of the Figures.

1. A young branch of apple tree badly attacked by the canker fungus.

2. A stout branch of an apple tree attacked by the canker


b
a
b
c
c
1
2
3

fungus. The fungus gained an entrance through the crack at *a*, and caused the curved cracks in the bark. At *b* and *c* lichens are growing on the bark.

3. A crack in the bark caused by the canker fungus. The groups of fungus fruit are seen springing from the sides of the wounds.

4, Whitehall Place, London, S.W.
August, 1899.

Revised, April, 1901.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 57.

BOARD OF AGRICULTURE AND FISHERIES.

External Parasites of Poultry.

The parasitic infestation of poultry causes far more loss than most breeders imagine. Birds are rarely examined, and the cause of their poor condition is not ascertained or even considered. The evil is allowed to spread unmolested, in many instances it spreads with great rapidity, and a general weak and unhealthy condition results. Insects and mites are the chief external parasites of poultry.

These parasites are most injurious to young chicks and "brood" hens. The persistent loss of chicks, and the failure of hens to bring off their young, are often due to the irritation caused by the presence of parasites upon their bodies—enemies that are frequently unsuspected. The insect and mite pests weaken the constitution and may predispose to other maladies, such as diphtheritic roup. Parasites on the young birds stunt their growth. What is termed "Scaly-leg" is due to a parasite—a mite. Another species of mite at the roots of the quills causes birds to pluck their feathers.

There are three distinct groups of insect and mite pests upon fowls, namely:—(1.) Fleas (*Pulicidæ*); (2.) Biting or Bird Lice (*Mallophaga*); and (3.) Mites (*Acarina*). The two former only are true insects, having the six insect legs; the *Acarina* have four pairs of legs when adult and are quite distinct from true insects. The fleas and some of the worst mites are armed with a piercing and sucking mouth; the bird lice or *Mallophaga* have biting mouths. The pests with piercing mouths weaken the birds not only by causing irritation but by actual robbing of blood. The biting lice, on the other hand, typically only cause itching and severe irritation. which keep the birds in constant unrest; it is not impossible, however, that on occasion they may draw blood. Most birds have each their distinct parasites, each species of louse only flourishing on a particular species of bird; duck lice, for instance, cannot live permanently upon fowls, and *vice versâ.*

Different species also seem partial to particular parts of the bird's body. The favourite positions seem to be the head, neck, rump, and under the wings. Some of these parasites live permanently on their hosts (lice and some mites), whilst others (fleas and some mites) go to and fro. Some mites live entirely upon, and even under, the skin, deep amongst the feathers and at their roots; some lice live like "ticks," with their head against the skin and their

body erect; whilst a single genus (*Lipeurus*) (Fig. 4) lives between the barbs of the feathers. All these parasites are encouraged by dirt and uncleanly conditions.

1. Fleas (*Pulicidæ*).

The fleas, which are true insects, belong to the order of flies (*Diptera*). They feed upon the blood. Only one species lives upon the fowl, namely, the Hen flea (*Pulex gallinæ*). This flea is abundant in dirty fowl runs, and especially in the nests where straw is used. The adult flea is dark in colour, and, as in all fleas, is devoid of wings. The fleas are provided with very sharp piercing mouths. They are not noticed on the birds, because they generally attack them at night; then, however, they do much harm, causing constant irritation and loss of blood, and depriving them of rest.

Life-history of the Hen Flea.—The female flea lays her eggs (nits) chiefly in the nests amongst dust and dirt and in the crevices of the walls and floor. These nits give rise to pearly white maggots, with brown horny heads; the maggots can often be found in the bottom of the nests amongst the dust (Fig. 1). These larvæ are mature in two or three weeks,

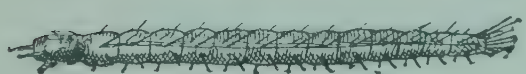


Fig. 1. Larva of hen flea (greatly enlarged).

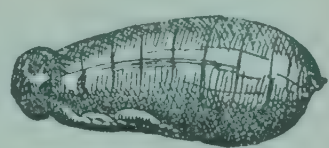


Fig. 2. Pupa of hen flea (greatly enlarged).

when they reach about one-sixth of an inch in length. In warm weather they may be full fed in even ten days. They then spin a pale cocoon amongst the dirt, in which they pupate. The pupa (Fig. 2) is at first pale brown, then dark chestnut brown. In this condition the flea remains ten to twenty-one days, when the pupa hatches into the adult. Hen fleas breed all the year round, but chiefly in warm weather. It is well to remember that, whenever there are dark and dirty hen roosts, there are sure to be numbers of fleas.

For *Prevention and Treatment*, see p. 4.

2. Biting Lice (*Mallophaga*).

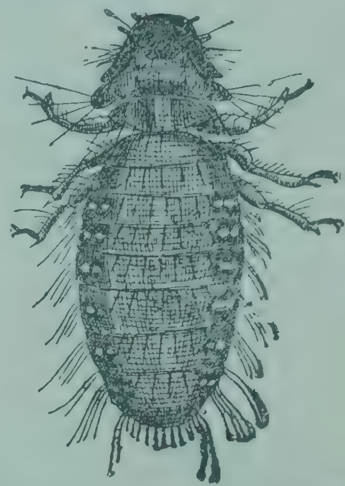
The bird lice belong to the group *Mallophaga*, quite distinct from human lice (*Pediculidæ*) and from lice of the genus *Hæmatopinus*, &c. The *Mallophaga* have not a piercing and sucking mouth, but their mouth is fitted for biting and cutting. They subsist upon the productions of the skin and fragments of feathers. They cause violent itching, and bite sharply, and must produce considerable pain when present

in large numbers, as they too frequently are. The feathers, especially the saddle hackles, generally show notched edges with lice infestation. Eight distinct species of lice attack fowls. The presence of these lice is generally ascribed to

FIG. 3.

Two Species of Fowl Lice.

Fowl louse (*Goniocotes hologaster*) (greatly enlarged).



Fowl louse (*Menopon pallidum*) (greatly enlarged).

too uniform or insufficient nutrition, and also to damp, dark, and dirty runs, especially those badly ventilated. Food, either when uniform or insufficient, has no effect upon their presence. Dark damp places, however, when dirty, are sure to harbour all these pests, especially when badly ventilated. It is also said that breed affects their presence, but observation tends to show that all breeds are more or less subjected to infestation. In every case they set up severe irritation and inflammation of the skin, which often leads to stunted growth, and even death. Lice and other parasites flourish on unhealthy birds.

Life-history of Biting Lice.—All the lice breed fairly rapidly. The eggs or nits are laid upon the down feathers

FIG. 4.

Fowl louse (*Lipeurus variabilis*) (greatly enlarged).

as a rule; they are often beautifully sculptured objects, oval in form. In about six to ten days they hatch into small, pale, active lice, which at once commence to irritate the birds. The adults are occasionally found in the nests. Before reaching the full-grown state these lice moult their skin ten or twelve times, there being little difference in each stage, except the gradual darkening of the markings.

Menopon pallidum (see Fig. 3) is the most troublesome of the fowl lice, and it runs with great nimbleness among the feathers. The head in front is somewhat angular and somewhat crescent-shaped. The temples are rounded and bear four bristles and a few hairs. The abdomen is oval and elongated, and each segment carries a series of bristles. In colour this pest is pale yellow, with bright fawn spots on the abdomen. *M. pallidum* has been kept alive for months upon fresh feathers, when the quill epidermis especially was consumed.

Lipeurus variabilis (see Fig. 4) may be found in considerable numbers among the feathers of the fowl, especially among the primary and secondary wing feathers. It has a narrow body, and the prevailing colour is pale yellow, with dark coloured bands and fawn-coloured spots. The lice are very small, the male measuring 1·9 millimetres and the female 2·2 millimetres. (There are approximately 25 millimetres to an inch.)

Two other forms belonging to the same section may infest chickens, viz., *Goniodes dissimilis* and *Goniocotes hologaster* (see Fig. 3). Compared with *Lipeurus*, their bodies are flatter and wider. The male *Goniodes dissimilis* measures almost 2 millimetres and the female 2½ millimetres. The head is wider than its length, while the abdomen is broad and oval, and bears two bristles on the middle of each segment, and three or four at the edges, where curved spots also occur. The general colour is whitish, the spots being darker, with fawn-coloured bands. *Goniocotes hologaster* is much smaller than *G. dissimilis*, the male being ·9 millimetres and the female 1·3 millimetres in length. The head is as wide as it is long, and it is broadest just behind the antennæ. This insect is of a yellowish colour which darkens at the thorax, and it has brownish black bands.

Prevention and Treatment of Fleas and Lice.

1.—Infestation is always worse in dirty and neglected runs and roosts, and such are a standing danger to more cleanly neighbours. Cleanliness and freedom will always put fleas and lice under a disadvantage, and not only should the nests, walls, and floor be kept clean and sweet, but also the ceilings and perches. To suppress these pests the houses should be cleaned down at least twice a year with a wash made of hot lime and soft soap, the ceilings, walls, and nests receiving a good coating; the wash should be fairly liquid so that it may run into every crack and crevice.* Early spring and autumn are the times for these applications. The perches are best treated with boiling

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* To every gallon of lime-wash add ¼ lb. of soft soap, previously dissolved in boiling water.

water and soft soap, or with an emulsion of kerosene. It is important that houses should be well built, with as few cracks and crevices as possible, for the pests congregate in such harbours and may escape from any wash used.

2.—Special attention should be paid to the nests, and these should be frequently cleansed and changed. Neither nest-boxes nor perches should be fixed, and relays of each should be at hand, so that they can be changed to ensure complete disinfection. The nest-boxes should be now and then cleaned out, and dressed with hot lime. Either dusting the prepared nests with fresh Persian insect powder (*Pyrethrum*) or putting a little sawdust or sand soaked in naphthalene at the bottom will have the desired effect. Pine-wood shavings, or wood-wool, placed in the nests instead of straw is most beneficial. No lice or fleas will live in it, owing to the aromatic odour given off from the wood. Care must be taken that the remedies employed do not affect the eggs in the nest.

3.—Regarding the infestation of the birds themselves, white precipitate seldom fails. The heads and necks of young chicks should be early dressed very sparingly, and this treatment should be repeated when necessary. White precipitate is a strong irritant poison, and needs the greatest care in its use, especially in the case of young chicks. It is best obtained as an ointment from the chemists. Hens selected for sitting should have a small quantity of this ointment rubbed in under the vent, head, and sides, and then be well dusted with fresh insect powder (*Pyrethrum*). Sitting hens are greatly tortured by parasites, and their young are often lost by neglect of these simple precautions. Dust-baths are the natural remedy for lice and mites, and fowls should never be kept without them. Sand and road dust, mixed with a small quantity of paraffin, will generally keep the birds free from vermin. In place of paraffin *Pyrethrum* powder may be used with the dust. Some poultry keepers find that when paraffin is added the birds avoid the dust-bath.

The supposed connection between "Gapes" and "Lice."—It has been stated that there is a connection between lice and the nematode worm, *Syngamus trachealis* (the "red-worm" of gamekeepers), that produces "gapes" in fowls and pheasants, and the one is thought to give rise to the other in some mysterious way. It may here be stated, therefore, that there is no life-history connection whatever between lice and "gapes." The life-history of that destructive scourge, the gape-worm,* has been clearly traced, and it is known that no intermediate host is required for its development.

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* *See* Leaflet No. 58 (*The Nematode or Round Worm Diseases of Poultry*).

3. Mites (*Acarina*).

Mites are very minute creatures, and they bear four pairs of legs when adult. Some live on the birds *at night*, as the red hen-mite (*Dermanyssus avium* or *gallinæ*) (Fig. 5); others are permanent parasites, *e.g.*, Itch mites or *Sarcoptes*, living at the base of the feathers,

FIG. 5.

Dermanyssus avium and ovum (greatly enlarged).

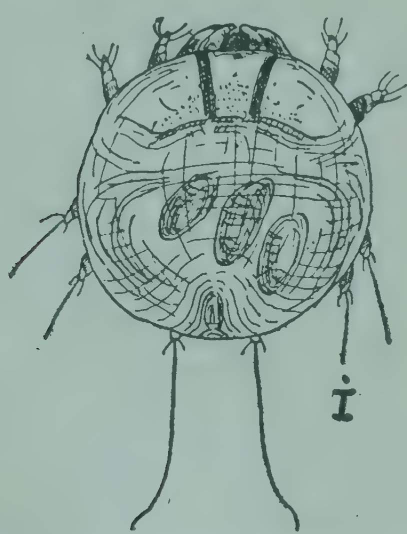
and popularly called "Depluming scabies" (Fig. 6); or, living under the skin, forming scabby growths, such as are seen on fowls' legs (*Sarcoptes mutans*). These skin mites, which are armed with a pricking mouth with which they torment the birds, especially at night, cause loss of condition, hinder sitting, and create loss in other ways.

The Red Fowl Mite (*Dermanyssus avium*).—The common red fowl mite is a very injurious form. It is a very minute creature and is yellowish white to dark red in colour, according to the amount of blood it contains, drawn from the birds. The mites are found in abundance in pigeon-houses and poultry-roosts, while they often attack cage birds. Both sexes are armed with a sharp rostrum, but the female is most bloodthirsty. They feed upon the birds only at night, and hide away in cracks and crevices in the nests, perches, floors, walls, and ceilings during the day. Brood hens are worried, and young birds become anæmic and may die. Numerous colonies can be found in the nests, especially in straw nests, with countless eggs and young forms, and quantities of cast skins. They are most prolific, and can also remain for months without any live host to feed on; hence the removal of the birds from the runs is useless as a remedy. The eggs hatch rapidly, and the young are at first silvery white, with six legs. They moult their skin a number of times, the cast skins forming a whitish or silvery powder often seen on the perches, and as the mites grow older they become darker in colour. Light and air are distasteful to them; damp, dark, and badly-ventilated places are where they flourish best. Breeding is especially rapid in spring and summer. The red fowl mite is often unobserved, owing to its strict nocturnal habits, and hence

the cause of the fowls keeping backward, and even dying, is not understood. When looking dejected and emaciated, birds should be examined at night, and if mites are found cleansing treatment should be at once resorted to as regards the houses and perches; some paraffin in the cleansing wash is excellent for the perches. If bisulphide of carbon is used for fumigating the houses, fumigation must be repeated, as the eggs escape. Transmission to man and other animals (*e.g.*, horse, dog, cat), is not unusual, but, although the mites for a time cause severe irritation, they will not remain for any length of time, and readily yield to treatment. Hens should not be permitted to roost in stables and sheds where other animals are kept.

FEATHER-EATING OR DEPLUMING SCABIES.—Feather-eating in poultry is often due to a minute parasitic mite (*Sarcoptes laevis*) at the roots of the feathers. It is generally supposed to be due to a "vicious habit," numerous absurd theories, such as idleness and thirst, having been put forward to account for it. There are two kinds of feather-eating, viz., "self-feather-eating" and the plucking of other birds' feathers. The former is chiefly due to the mites living upon and irritating the roots of the quills. The form on the fowl makes its appearance about April, and is most prevalent in spring and summer. Beginning at the rump, the disease may spread to other parts, the head and neck often being badly affected. The mites can be easily found amongst the white powdery matter at the base of the quill. The fowls pluck out the feathers to get rid of the irritation

FIG. 6.



Sarcoptes laevis. Egg-bearing female (greatly enlarged).

caused by the mites at their base. Besides the loss of feathers the suffering birds become thin, and fall off in egg-laying. Lice, also, are partly accountable for feather-plucking. The birds in picking at the mites and lice pull out the feathers.

Prevention and Remedies.—As the mite disease is contagious, isolation of the affected bird is the first step, especially if it be a cock. The mites readily yield to treatment with oil of cloves rubbed into the infected area. A mixture of one part of creosote to 20 of lard or vaseline is still more successful. Another measure is to wet the base of the feathers with soapy water, and then dust the birds with fresh *Pyrethrum*.

SCALY LEG.—This well-known disease is also due to a mite (*Sarcoptes mutans*). This complaint is a serious matter and very prevalent. The scales of the legs and feet become raised and separated, and a chalk-like excretion accumulates between and over them. Rough lumpy crusts are formed, and under these and the scales the mites live and breed. The disease is slightly contagious, and may pass to other birds than fowls. Infected birds are lame, they have a difficulty in perching, and they fall off in condition.

Prevention and Remedies.—Isolation of diseased birds is most essential. Removal of the crusts without causing bleeding, and then the application of a mixture of creosote (one part) and lard (20 parts), will be found sufficient. The legs should be previously bathed in hot water in order to soften the crusts. A mixture of equal parts of flowers of sulphur and vaseline rubbed into the limb also cures this complaint. In every case the limb, some days after treatment, should be well cleaned with hot water and soft soap. It is most important that any new stock should be examined, especially cocks, and if any signs of parasites are seen they should be cleared off before the birds are given their freedom.

NOTE.—If exhibits of poultry infested with parasites were prohibited by poultry-show committees, it would force attention to the subject in a way that could not fail greatly to reduce parasitic infestation.

The pests mentioned above are very small, and a good lens or microscope is required for their examination.

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August, 1899.
Revised, October, 1911.

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A pamphlet containing 16 *leaflets dealing with Poultry and Bees, their Breeding and Management, can be obtained from the same address, price* 1*d. each* (*or* 9*d. per dozen copies*) *post free.*

BOARD OF AGRICULTURE AND FISHERIES.

The Nematode or Round Worm Diseases of Poultry.

The Nematode worms are characterised by the rounded and generally thread-like character of the body. The sexes are separate. Some are free-living in the open, but the majority are parasitic either on plants (*e.g.*, eelworms), or on animals. Of the round worms parasitic in poultry the two worst genera are *Syngamus* and *Heterakis*.

I. The Gape-worm (*Syngamus trachealis*).

The Gape Worm (*Syngamus trachealis*), male and female (mag., line showing natural size of female).

Gapes is a disease caused by a nematode or round-worm which takes up its abode in the windpipe and sometimes in the bronchial tubes. It is scientifically named *Syngamus trachealis*. The Gape-worm is also known as the Red-worm and Forked-worm. Not only fowls and turkeys, but pheasants, partridges, sparrows, linnets, starlings, rooks, martins, swifts, and green woodpeckers are also invaded by this parasite. The disease is caused by the worms taking up their abode in the air-passages, attaching themselves by their circular mouths, sucking the blood, irritating the lining membrane, and causing inflammation. These pests, if present in large numbers, also block up the windpipe and stop the passage of air to the lungs. In either case the birds may succumb. Chickens up to four weeks old are the most susceptible.

The Gape-worm is nearly always found in copulâ inside the host, the small male worm being permanently attached to the female towards her head end, and the two worms making a fork; hence the name of Forked-worm. The smaller branch of the fork is the male.

It is chiefly in chicks and turkey poults that gapes causes the greatest mortality, although old birds are sometimes attacked. The birds contract the disease by picking up eggs or embryos from infected ground or polluted water; probably also in eating earthworms that have swallowed the eggs of the Gape-worm. That wild birds play some part in the dissemination of gapes is also extremely probable.

The *symptoms* of gapes are a curious listless gaping of the mouth, a wheezing cough and stretching forward of the neck, a ruffling of the feathers, and a drooping of the wings, while there is frequently an appearance of frothy saliva in the mouth and sometimes in the nostrils.

Description.

The Gape-worm is reddish in colour, often bright red. The male measures up to one-fifth of an inch in length and the female up to four-fifths of an inch. The mouth is circular or bell-shaped, and at its base are six horny lancets or processes surrounding the opening that leads into the gullet. The eggs are oval and very minute, measuring barely $\frac{1}{250}$ of an inch.

As a rule, a number of worms may be found together in the fowl's windpipe, sometimes as many as twenty crowding in one particular part of the tube.

Life History.

The eggs are not laid, but when the female worms become mature and full of eggs they and the attached males are coughed up by the bird. These worms, coughed out, lie about on the ground, and they may be picked up by the birds and eaten, and the eggs liberated; or, lying on the ground or in water, they sooner or later burst. Thus the eggs and embryos are scattered, and the poultry run becomes infested. The eggs hatch—in damp places especially—into tiny white embryo worms, and both eggs and embryos, being picked up by a chick, are capable of directly developing into the adult Gape-worm.

Experiments have shown that birds fed with ova and embryos of *S. trachealis* will develop gapes, and thus no second host, such as we find in the tapeworms, is necessary. Although a second host is not necessary, numbers of the eggs and embryos are swallowed by earthworms, and doubtless fowls may contract gapes when eating these worms, which thus act as carriers of the disease.

Treatment.

1.—Houses, coops, and hatching boxes should be thoroughly cleansed, being treated with hot lime-wash.

2.—Water vessels should be kept scrupulously clean and only pure water given to the birds. The drinking troughs are best cleansed by being put in boiling water and well scalded.

3.—Any bird showing signs of the disease should be isolated.

4.—Chicks should not be kept with the stock birds. Fresh breeding ground should be used if possible every year. The worst outbreaks are always on overstocked land.

5.—If the birds are kept in small runs, the runs should be disinfected either with gas-lime, or with hot powdered lime, or by watering with a 1 per cent. solution of sulphuric acid.

6.—It is most essential that all chicks which die from gapes should be burnt rather than buried.

7.—Local treatment of the throat with a feather soaked in carbolic oil, turpentine, &c., is specially meant for cases where the upper air passages are blocked with plugs of worms. Such treatment must be carefully applied. The worms may also be partly removed from the windpipe by means of a feather, dipped in oil of cloves or eucalyptus oil, pushed down the windpipe and turned round and round. Such treatment, however, will fail to reach the worms situated lower down in the bronchi.

8.—A fumigating box, in which several birds can be placed at once, is useful; either *Camlin powder* or finely ground chalk and camphor blown into the box will loosen the worms, which the birds will expectorate during the violent fits of coughing the powder produces.

9.—A correspondent has informed the Board of the following remedy as having proved very effective in cases of gapes in poultry :—" A brick is placed on the fire till nearly red hot. It is then taken out, put at the bottom of a large sized pail and a small quantity of ordinary carbolic oil poured on it. The chickens which require treatment should be previously placed in an old basket, which is placed on the mouth of the pail, but not touching the brick. The fumes from the oil rise and pass through the interstices of the basket, and are kept from escaping too fast by a cloth which is thrown over the basket. The chicks are kept here until nearly suffocated, and then immediately placed in the open air. The birds treated were unwell for a day or two, but the treatment was so effective that only in a few cases had it to be repeated."

Fumigation with sulphurous acid or chlorine would probably prove superior in its effects to fumigation with carbolic acid, which is very poisonous to the system as well as having a local effect.

II. White Intestinal Worms.

Death is not frequent from intestinal worms, yet weakness is very often caused by two Nematode worms, *Heterakis*

papillosa and *Heterakis inflexa*. These worms are found in different parts of the small intestine, often in considerable numbers. Sometimes they interfere with the passage of food by forming a plug and blocking up the alimentary canal.

Birds infested with them are usually ravenous and yet keep losing condition.

Description.

Both worms are white or yellowish white. *Heterakis papillosa* resembles a small pin without the head, the body thinning out at both ends. The male measures $\frac{1}{4}$ to $\frac{1}{2}$ inch in length, and under the microscope shows at the hind end two projections or spicules. The female measures $\frac{3}{8}$ths to $\frac{5}{8}$ths of an inch in length and has the hind end of the body distinctly more drawn out than in the male.

Heterakis inflexa is a somewhat larger worm and is not found straight but with body twisted or curled. The male measures from $1\frac{1}{4}$ inch to 3 inches, and the female from $2\frac{1}{4}$ inches to 4 inches.

Life History.

The worms are adult in the bird's intestines; and here the eggs are laid. The eggs are passed to the outside, and these or the young embryos reach the bird again in dirty water or from the ground.

Treatment.

1.—Diseased birds should be isolated.

2.—The worm can easily be expelled by a dose of Thymol; one grain made up in a dough pill may be administered morning and night.

3.—Similar good results have sometimes been obtained by the use of one to three grains of Santonine, given in the same way, the one grain for chicks.

4, Whitehall Place, London, S.W.,
October, 1899.

Revised, April, 1912.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 19 *Leaflets dealing with Poultry and Bees, their Breeding and Management, may be obtained from the same address, price* 1d., *or* 9d. *per dozen copies, post free.*

Leaflet No. 59.

BOARD OF AGRICULTURE AND FISHERIES.

Improvement of Land Acts.

(England and Wales.)

The Improvement of Land Acts, 1864 and 1899, enable owners of land with the sanction of the Board of Agriculture and Fisheries to borrow money for agricultural and other improvements and to charge the cost of the works upon the lands improved. The maximum period over which such rentcharges may extend is 40 years, but it must not be assumed that the full term will always be allowed. The period in each case will be determined by the Board, regard being had to the character and probable duration of the improvement.

Upon a landowner applying to the Board for a charge under these Acts, the Board cause the land proposed to be improved to be inspected by their Inspector, upon whose report, if satisfactory, they sanction the proposed improvement by a Provisional Order, and until such Order has been issued the works should not be commenced. When the works have been completed and passed by the Inspector, the Board issue their Absolute Order, charging the lands improved with the cost of the works and any reasonable expenses incident to the application, the amount of the charge being repayable by equal half-yearly instalments of principal and interest extending over the period for which the charge was sanctioned.

The Board have no public funds at their disposal from which advances can be made to landowners for carrying out improvements.

The Lands Improvement Company of 1, Great George Street, Westminster, is authorised by special Acts of Parliament to advance money for the execution of certain improvements, and by a resolution duly passed under the Improvement of Land Act, 1899, these have been extended so as to comprise any improvement authorised by the Improvement of Land Act, 1864, or an enactment amending it.

The various improvements which may be the subject of a charge under the Acts are as follows :—

1. Drainage, including the straightening, widening, or deepening of drains, streams, and watercourses.
2. Irrigation ; warping.
3. The provision of drains, pipes, and machinery for supply and distribution of sewage as manure.

4. Embanking or weiring from a river or lake, or from the sea or a tidal water.
5. The erection of groynes, sea-walls, and defences against water.
6. Inclosing; straightening of fences; re-division of fields.
7. Reclamation; dry warping.
8. The making of farm roads, private roads, and roads or streets in villages or towns.
9. Clearing; trenching; planting.
10. The erection of cottages for labourers, farm servants, and artisans, employed on the land or not, and of dwellings available for the working classes.
11. The erection of farm houses, offices, and outbuildings and other buildings for farm purposes.
12. The erection of saw-mills, scutch-mills, and other mills, water-wheels, engine-houses, and kilns, which will increase the value of the land for agricultural purposes, or as woodland or otherwise.
13. The construction of reservoirs, tanks, conduits, water-courses, pipes, wells, ponds, shafts, dams, weirs, sluices, and other works and machinery for supply and distribution of water for agricultural, manufacturing, or other purposes, or for domestic or other consumption.
14. The making of tramways, railways, canals, and docks.
15. The erection of jetties, piers, and landing-places on rivers, lakes, the sea or tidal waters, for facilitating transport of persons, and of agricultural stock and produce, and of manure and other things required for agricultural purposes, and of minerals and of things required for mining purposes.
16. The construction of markets and market-places.
17. The laying out and construction of streets, roads, paths, squares, gardens, or other open spaces, for the use, gratuitously or on payment, of the public or of individuals, or for dedication to the public, the same being necessary or proper in connection with the conversion of land into building land.
18. The making of sewers, drains, water-courses, pipes, fencing, paving, bricks, tiles, and other works necessary or proper in connection with any of the objects aforesaid.
19. The sinking of trial pits for mines, and other preliminary works necessary or proper in connection with the development of mines.
20. The construction of bridges.
21. Making any additions to, or alterations in, buildings reasonably necessary or proper to enable the same to be let.

22. The erection of buildings in substitution for buildings within an Urban District taken by a Local or other Public Authority or for buildings taken under compulsory powers.
23. The reconstruction, enlargement, or improvement, of any of the works referred to above.

The erection or improvements of a Mansion House may also be the subject of an improvement charge, but in general the charge will be subject to the provisions of the Limited Owners Residences Acts, 1870 and 1871.

Improvement charges can also be obtained for certain assessments in respect of public works, such as drainage and street improvements, and for subscriptions for stock or shares of a Railway, Canal, or Water Company whose works will improve the land comprised in the charge.

4, Whitehall Place, London, S.W.,
April, 1912.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Goat Moth (*Cossus ligniperda*) and Wood Leopard Moth (*Zeuzera æsculi*).

Goat Moth, larva, and pupa, all natural size.

The Goat Moth.

Trees attacked.

The caterpillars of this moth bore galleries in the stems of many species of broad-leaved trees, *e.g.*, willow, poplar, walnut, birch, elm, beech, lime, sycamore, ash, and various fruit trees. The softer woods are more commonly infested.

The caterpillars are large and a great number may be found at work in the same tree; the wood, on this account is so tunnelled and honeycombed as to be rendered useless for technical purposes.

Indications of infestation.

(*a.*) The little heaps of excrement and frass thrown by the feeding caterpillars from their galleries to the outside.
(*b.*) The tunnelled stems broken by the wind.
(*c.*) The odour of the caterpillars (the walls of the galleries in the wood also smell), the odour being that of the acid distilled from wood; by some the odour has been compared to that of the goat.

Isolated trees, or those in an avenue or at the edge of a wood, are chosen by the females for their egg laying in preference to trees in close forest or close growth.

Description.

Moth.—The goat moth, which flies at night, is large and plump. The female measures 1½ inches or more in length, and over 3 inches in spread of wing; the male is somewhat smaller. The head is small and the eyes large; the proboscis and antennæ are short. The antennæ of the male are distinctly comb-like, whilst those of the female are saw-like. The fore wings are pale-brown mottled with ashy-grey, and have numerous irregular black streaks and marks; the hind wings are darker greyish-brown. The thorax is densely hairy, brown and grey in front, and with a blackish band across it behind. The large heavy abdomen is grey with whitish rings.

Caterpillar.—The caterpillar is somewhat flattened, and hence the galleries are oval in shape. When young the caterpillar is dull pink, but as it grows it becomes yellowish flesh-coloured at the sides and on the under surface, the upper surface being red. The head is black; the segment behind the head bears a dark shield, and the segments have fine bristle-like hairs. The full-grown caterpillar may measure about 4 inches.

Pupa.—Pupation takes place in the burrow in the stem, near to the outside, the chrysalis being surrounded by a cocoon covered by wood chips and sawdust. Sometimes the caterpillar leaves the tree and pupates in the soil, in which case the cocoon consists chiefly of particles of soil.

Life History.

The moths fly in June and July; the eggs are laid in little heaps in cracks and crevices in the bark generally very low down, but sometimes up to the height of a man. The caterpillars on hatching feed at first below the bark, but later they gnaw irregular ascending galleries in the wood. In cases of overcrowding (and more than 100 caterpillars have been taken from one stem) some of the caterpillars may leave the tree and bore into another. When full grown the caterpillar

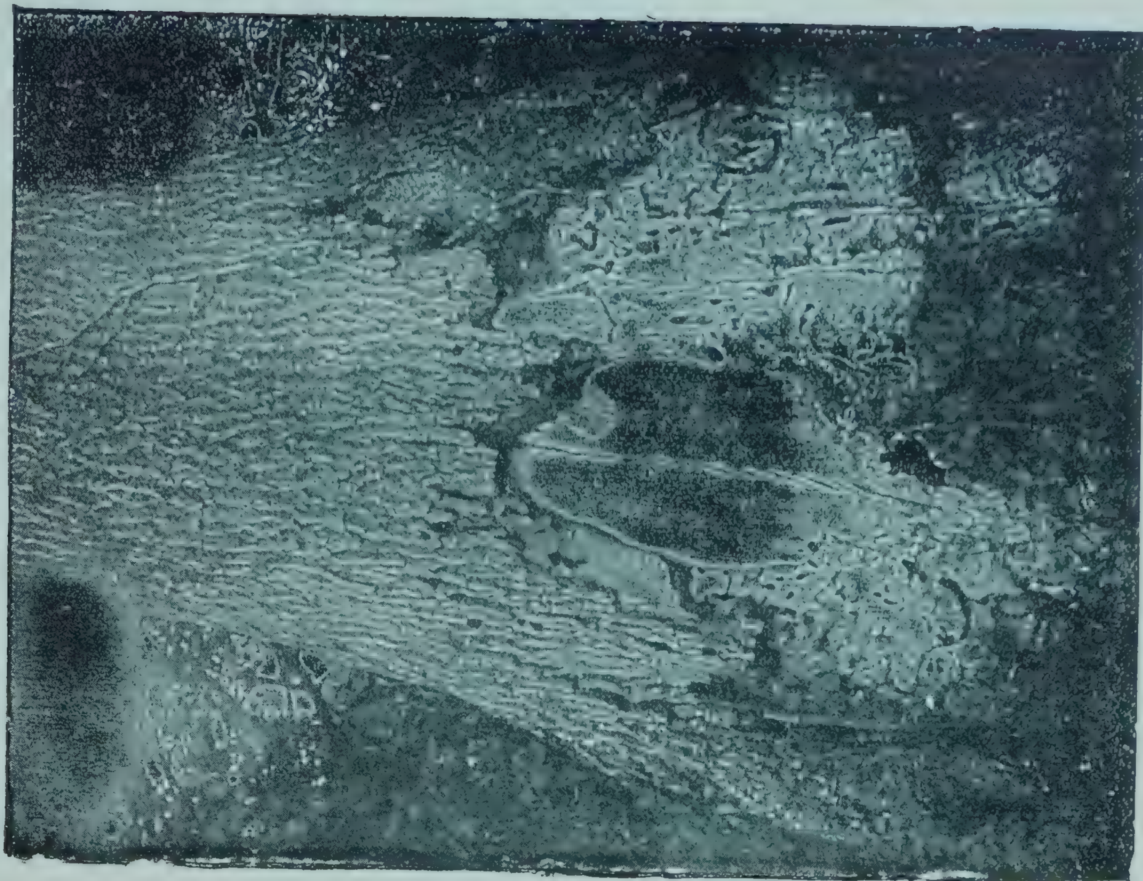
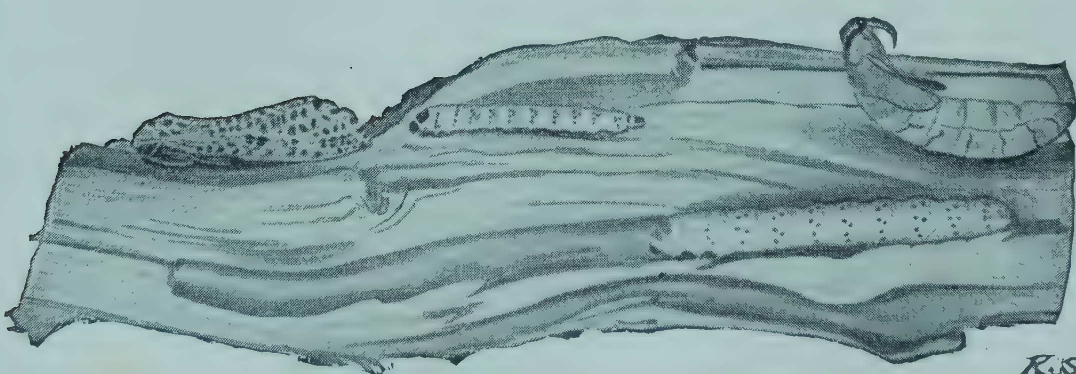


Fig. 2.—Ash Tree

Fig. *c*. Portion of Ash Tree with larva of Goat Moth *in situ*.



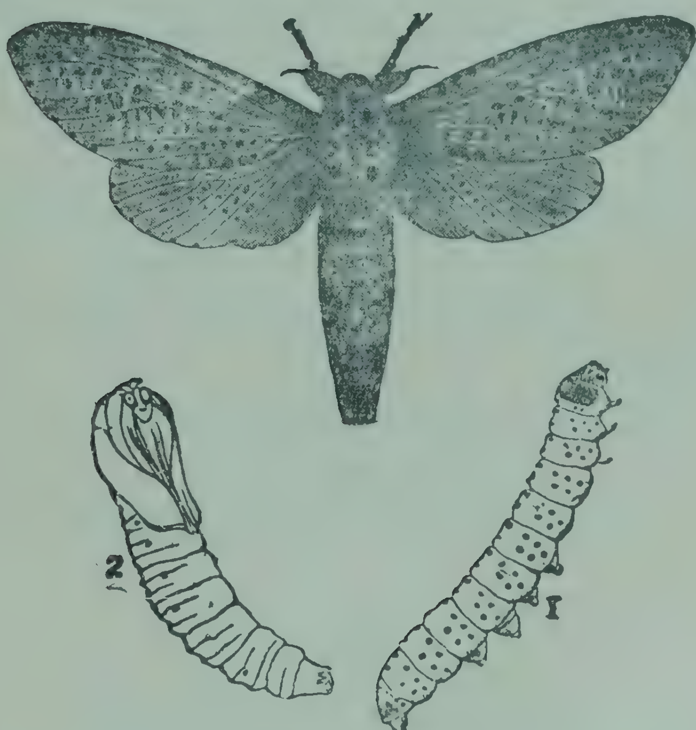
R.S.M.

The Wood Leopard Moth.—Figure showing young caterpillar, well grown caterpillar, pupa case, moth at rest, and a larval gallery.

pupates, and the pupation stage lasts about a month or on occasion somewhat longer. Before the emergence of the moth the pupa pushes its way partly out of the burrow in the tree, and the empty pupal skin may be seen projecting after the emergence of the moth. The cocoon has been found projecting from the soil of a garden near an infested balsam poplar.

The life cycle typically lasts for two years, *i.e.*, from eggs laid in July, 1905, caterpillars will hatch and bore below the bark. Passing the winter in the stem the caterpillars then tunnel in the wood, where they will live during the whole of 1906 and until June of 1907. Pupation will now take place, the moths issuing to start a new generation in July, 1907.

The Wood Leopard Moth.



Male Wood Leopard Moth; 1. Caterpillar, 2. Chrysalis, all natural size.

Trees attacked.

Like the Goat Moth this pest has importance both for the forester and the fruit-grower. The caterpillars of *Zeuzera æsculi* feed in the stem and branches of a number of broad-

leaved species of trees, *e.g.*, lilac, lime, sycamore, birch, beech, oak, sweet chestnut, ash, willow, poplar, and such fruit trees as apple, pear, and cherry, where they may cause considerable harm. Though its specific name is that of the horse-chestnut the moth does not lay so much on it as on other trees, but its caterpillar galleries have been several times found in the very young branches of this tree, the tunnelled twigs hanging down broken by the wind. In the case of this moth, the caterpillars are not found many together in an attacked stem, but generally singly. The presence of the caterpillar may be betrayed by its copious out-throw of frass and wood-coloured excrement. The moth is frequently found in the Metropolitan districts, and sometimes causes considerable destruction to trees and shrubs in the public parks and private gardens of the metropolis.

Description.

Moth.—The moth, which is named "Leopard" on account of its spotted wings, measures between 2 and 3 inches in expanse of wings in the case of the female, the males being smaller. The fore wings are white, with a number of black or blue-black spots. The hind wings are similarly marked, but the spots are fainter. The thorax is white, with 6 large dark spots arranged in pairs, and a smaller spot between the hindmost pair.

Caterpillar.—The full-grown caterpillar may measure 2 inches. It is white or yellow-white in colour with black spots; the head is dark, the joint behind the head bearing a black shield or plate, whilst a black plate is also present on the last segment.

Pupa.—The pupa is brown and may be found at first just below the place of exit, and later, empty from the emergence of the moth, it may—till the weather destroys or displaces it—be seen projecting from the tunnel in the infested tree.

Life History.

The moths lay their eggs singly on stems and branches late in June or July, and the caterpillar on hatching gnaws at first irregularly below the bark. After wintering the caterpillar bores into the wood, and the gallery or tunnel, running in the long axis of the infested stem, is round and regular and may reach 8 inches in length. The life cycle may take two years for its completion, when the dates quoted for the Goat Moth apply equally well in the case of the Wood Leopard Moth. The caterpillars have been known to leave their first feeding place and attack younger and fresher growths.

Preventive and Remedial Measures.

1. Where Leopard Moth caterpillars infest young branches or young stems, these should be cut and burned, as they would probably be killed in any case.

2. The galleries of the Wood Leopard caterpillars are regular, and in older stems a piece of wire or a strong twig pushed into the tunnel vigorously may reach and kill the caterpillar.

3. Trees infested with the Goat Moth caterpillars should be cut down and the brood destroyed.

4. As a preventive against the egg laying of the Goat Moth smear or paint over the lower part of the stem, up to the height of a man, with a mixture of clay and cow-dung, or a mixture of clay, soft soap, and paraffin.

4, Whitehall Place, London, S.W.
October, 1899.
Revised, July, 1905.

BOARD OF AGRICULTURE AND FISHERIES.

Sheep-Scab.

Sheep-Scab may be described as a parasitic rather than as a purely contagious disease, affecting the woolly parts of the body, and due to the presence on the skin of a species of mite or acarus known scientifically as *Dermatodectes ovis*, or *Psoroptes communis*.

Symptoms of Attack.

One of the first symptoms apparent in a sheep that has contracted scab is restlessness combined with a desire to bite the affected part, or to rub against posts, fences, hurdles, or even other members of the flock. This restlessness is the result of the irritation produced by the mites pricking the skin of the sheep in their endeavour to obtain food. The constant biting and rubbing of the sheep to allay the irritation causes injury to the skin, which is followed by an exudation of serum, and the formation of crusts or scabs, under the edge of which the parasites and their ova are to be found.

As the mites increase in number they move from the scabs to the more healthy parts of the skin and thus extend the area of the diseased parts.

The injury to the skin is followed by shedding of the wool, and the fleece becomes broken and tufted, or matted together, giving the animal a ragged appearance. Even where the wool does not detach itself from the skin, it assumes a dead-white bleached appearance.

When a sheep is found to present the above symptoms the owner should at once examine the animal, and, if he has any doubt as to the nature of the disease, he should call in the assistance of his veterinary adviser to discover whether the itching and rubbing are due to the presence of the sheep-scab mite, or to other causes.

The most convenient method of examining a piece of wool or crust taken from a sheep suspected of scab is to spread it out upon a dark surface, and place it in the sun or any other warm position. If it be a case of scab the mites will be seen as small opaque specks moving about on the wool or perhaps on the surface beneath it. These moving objects should then be examined with a pocket lens or with a microscope of low power, when the parasites and their eggs will present a characteristic appearance.

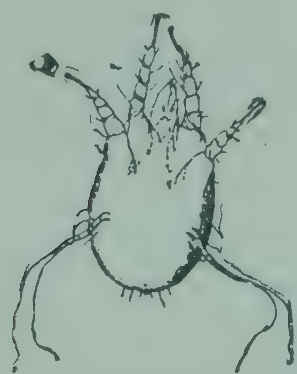


FIGURE 1.

An immature Sheep-Scab Mite much magnified.

The parasites and their eggs are usually abundant at the margin of crusts or scabs on the surface of the skin, and if a small portion of the crust and wool, after being softened in a mixture composed of glycerine and a solution of potash or soda, is teased out and placed upon a microscope slide there will often be found, in cases of scab, whole mites, or portions of the detached legs, and eggs mixed up with the fibres of the wool and fatty matter.

The parasites of sheep-scab may be seen by the naked eye, but examination is greatly facilitated by the use of a pocket lens, or a low-power microscope. Now that the decisions of the Veterinary Inspectors of Local Authorities in Great Britain are followed by serious consequences to the owners if sheep are certified to be affected with scab, it is most important that no errors should be made in diagnosis. It therefore becomes necessary that all enquiries into reported outbreaks should be conducted on the above lines and with due care, because, unless the particular mite can be discovered the existence of the disease may be questioned.

Description.

The mature acarus or mite that causes scab in sheep measures $\frac{1}{40}$ to $\frac{1}{50}$ of an inch (·52 — ·62 mm.) in length, the female (Fig. 2) being somewhat larger than the male (Fig. 3). Both male and female are provided with four pairs of legs. Each foot of the first three pairs of legs of the male is furnished with a sucker-disc ; but in the case of the female this disc on the third pair of feet is replaced by long hairs.

FIGURE 2.

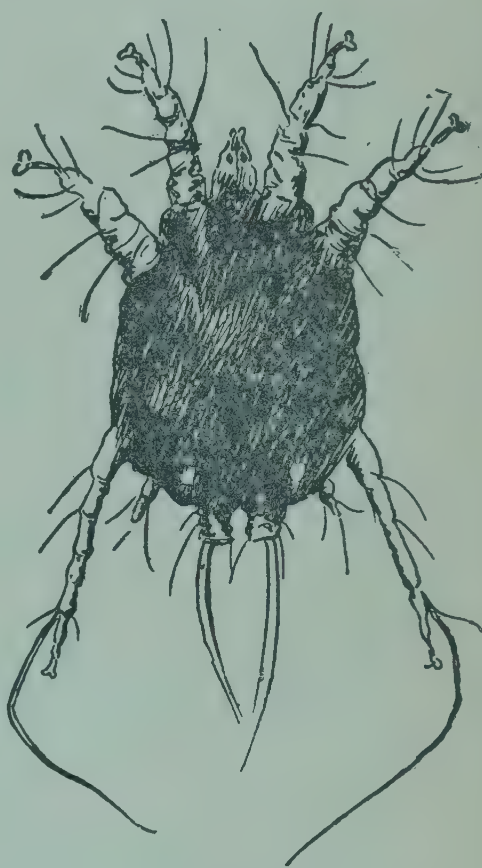


FIGURE 3.

Sheep-Scab Mites (*Psoroptes communis*). Figure 2, Female × 65. Figure 3, Male with copulatory suckers extended, × 65.

The egg is about $\frac{1}{125}$ of an inch (·2 mm.) long.

The immature mites or larvæ (Figure 1) have only three pairs of legs.

Parasites very similar in form and size are also found on the horse, dog, and other animals, producing the disease

commonly called mange, but the mange mite does not produce sheep-scab. It may therefore be accepted that where sheep become affected with sheep-scab they must have previously been in contact with diseased sheep, or with fences, posts, hurdles, or other objects against which diseased animals have rubbed.

Life History.

Since the life history of the sheep-scab parasite has a very important practical bearing upon that part of the Sheep-Scab Order of 1905 which deals with the dipping of sheep, it should be explained that after the parasite has been transferred from the diseased to the healthy sheep the female lays its eggs and dies. These eggs under favourable circumstances are hatched in about seven days, and the young female parasites, after passing through the various stages of their development, arrive at maturity in about two weeks, when they, in their turn, proceed to lay eggs.

In all instances where sheep exhibit manifest evidence of scab, there are present not only living parasites but also eggs which may be newly laid, or are on the point of hatching. While therefore one dipping, properly conducted, will have the effect of killing the living mites and destroying some of the eggs, it is absolutely necessary, if a perfect cure is to be established, to have recourse to a second dipping, which should be carried out not earlier than the 10th, nor later than the 21st day following the first dipping. If the dipping has been done with proper materials, two dippings will generally suffice, but if any doubt exists, a third dipping should be undertaken after a similar interval.

Preventive Measures.

Where sheep-scab exists, or is suspected, it is the duty of the owner of the sheep, under Article 1 of the Sheep-Scab Order of 1905, to give notice of the fact of the sheep being so affected or suspected to the nearest police constable; but even in the absence of any suspicion of disease preventive measures against sheep-scab may with advantage be undertaken periodically.

Needless to say dipping will only be effective if proper materials are used, and if the operation is carried out in a thorough manner. The substances most commonly employed

to kill the scab-mite are preparations of white arsenic, carbolic acid, tobacco juice, or sulphur. Some flock-masters compound home-made dips, but most rely upon one or other of the many patent dips that are now upon the market.

In pursuance of the recommendation contained in paragraph 34 of the Departmental Committee's Report* [Cd. 2,258] on Sheep-Dipping, the Board have incorporated in the second Schedule of the † Sheep-Scab Order of 1905 particulars as to the composition of three preparations which have been proved by experiment to be suitable for use as sheep-dips without detriment to the fleece of the animal dipped, and, if properly employed, to be effective against sheep-scab,—as follows :—

Prescriptions for Sheep-Dips approved by the Board for Sheep-Scab.

(Quantities for 100 gallons of bath.)

1. Lime and Sulphur.

Mix 25 lb. of flowers of sulphur with 12½ lb. of good quick-lime. Grind the mixture with water until a smooth cream without lumps is obtained. Transfer this to a boiler capable of boiling 20 gallons, bring the volume of the cream to 20 gallons by the addition of water, boil and stir during half an hour. The liquid should now be of a dark red colour; if yellowish, continue the boiling until the dark red colour is obtained, keeping the volume at 20 gallons. After the liquid has cooled, decant it from any small quantity of insoluble residue, and make up the volume to 100 gallons with water.

2. Carbolic Acid and Soft Soap.

Dissolve 5 lb. of good soft soap, with gentle warming, in 3 quarts of liquid carbolic acid (containing not less than 97 per cent. of real tar acid). Mix the liquid with enough water to make 100 gallons.

3. Tobacco and Sulphur.

Steep 35 lb. of finely-ground tobacco (offal tobacco) in 21 gallons of water for four days. Strain off the liquid, and remove the last portions of the extract by pressing the residual tobacco. Mix the whole extract, and to it add 10 lb. of flowers of sulphur. Stir the mixture well to secure an even admixture, and make up the total bulk to 100 gallons with water.

NOTE.—The period of immersion in these dips should not be less than half a minute.

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* This is a Parliamentary publication, and can be obtained, through any bookseller, from Wyman & Sons, Ltd., Fetter Lane, London, E.C., at the price of 3*d.* The volume of Evidence is numbered Cd. 2,259, price 2*s.* 4*d.*

† A copy of the Order can be obtained on application to the Board.

Although the Board have not included in the above-mentioned schedule any preparation containing arsenic, it is not to be assumed from this omission that the Board do not concur in the view that the arsenic dips are thoroughly effective against sheep-scab. The possible danger to human beings attendant upon the preparation of such dips renders it advisable, however, that they should be compounded by qualified persons only.

The Board recognise that there are a large number of sheep-dips on sale which may be regarded as equally effective against sheep-scab, but it must be borne in mind that in order to comply with the provisions of the Sheep-Scab Order, and the various Sheep-Dipping Orders, the dip used must be an "efficient sheep-dip," that is, one approved by the Board for sheep-scab, or purporting to be so approved. (Over 400 preparations have been so approved.)

Where approved preparations are employed the amount of dilution should be no greater than that stated on the label on the package in which the dip is contained, and the instructions issued by the manufacturer as to the period of immersion should be carefully observed. The dip bath should at all times be of sufficient volume to secure the complete immersion of the sheep.

Sheep dips approved by the Board are required to contain sufficient of one constituent to make the dip effective for the cure of sheep-scab at the strength approved. It is, therefore, inadvisable to make up the dip-bath by mixing two or more dips containing different ingredients, even in cases where each dip has been approved for use by itself. For instance to mix carbolic and arsenic dips may result in destroying the efficacy of both ingredients, and even the mixing of dips containing the same ingredients may result in the bath being below standard. In some cases also, the use of mixed dips may injure the sheep.

Of the two forms of bath—hand and swimming—the latter is greatly to be preferred. The advantages of the swimming bath are: (1) The sheep, being in a natural position, may be completely immersed, even in a poisonous solution, with comparatively little danger; (2) sheep in lamb may be dipped with much less risk; (3) the motion of swimming allows no portion of the fleece to escape contact with the solution; (4) the work is more easily and therefore more effectively performed; (5) a larger number of sheep can be dipped in a given time and with fewer operators. Different forms of bath are described in Leaflet No. 145 (*Sheep Dipping*), and in the *Journal of the Board of Agriculture* for July, 1908.

On pastoral hills, or where the boundary fences are defective, it is difficult, if not impossible, to prevent a certain amount of mixing between sheep belonging to adjacent owners, and it is no easy matter to avoid the risk of attack. On commons the danger of contamination of the flock is still greater. With ordinary precautions, however, scab should be difficult of introduction to a well-fenced farm. These precautions consist in using reasonable care in the purchase of sheep, and in making a point of never bringing fresh sheep on to the ground without first twice dipping them at an interval of not less than 10 or more than 21 days. If sheep are exposed at a market, without effecting a sale, the animals should be similarly dipped before they are returned to their grazings or are mixed with other sheep. These are safe precautions under any circumstances, and especially so in scab-infected districts.

NOTE.—A suggestion has been made to the Board that there is a possibility of some pollution of streams and ponds arising from the improper disposal of the dipping material after sheep-dipping has been done. Flock-masters should bear in mind that this residue is necessarily injurious to animal life when a poisonous dip has been used, and should, therefore, be careful to dispose of it in such a way as to avoid any possible contamination of streams, ponds, or drinking places.

4, Whitehall Place, London, S.W
November, 1899.

Revised, May, 1910.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 19 *leaflets dealing with Diseases and Insect Pests of Farm Animals may be obtained from the same address, price* 1d., *post free.*

BOARD OF AGRICULTURE AND FISHERIES.

The Pear and Cherry Sawfly.

(*Eriocampa limacina*, Cameron.)

Slugworms (Larvæ of *Eriocampa limacina*) upon a leaf.

The extremely repulsive larva of this sawfly is frequently most destructive to pear and cherry trees. It also infests apple, plum, damson and peach trees, and is occasionally seen upon oak, birch, and other forest trees, as well as on some species of thorns. In the dry seasons of 1899 and 1901, cases occurred where nearly all the leaves fell from pear trees in consequence of the continuous attacks of larvæ of this insect. The larvæ are sometimes termed "slugworms" or "snegs."

The adult sawfly is harmless—although by it the eggs are laid—but the larva or slugworm eats away the upper epidermis of the leaf and destroys the soft tissue or parenchyma between the veins; the veins and the lower epidermis are left intact. To begin with, the leaf is eaten in patches here and there, but ultimately every particle of green is devoured. Severe infestation entirely prevents the production of fruit and even a slight attack has a marked effect on the crop of pears, which cannot come to perfection if the foliage is injured.

This insect does much harm to pear and cherry trees in America. As early as 1797, according to Harris, the larvæ caused great injury. "Small trees," he says, "were covered

with them, and their foliage entirely destroyed, and even the air, by passing through the trees, became charged with a disagreeable and sickening odour given out by these slimy creatures." This has also been noticed in England. In California the pest is often very troublesome, especially to pear trees. Professor Saunders states that in 1874 *Eriocampa limacina* was unusually abundant in Ontario, in many cases destroying the foliage so thoroughly that the trees looked as if they had been scorched by fire. This insect was at one time called *Selandria cerasi* in America. It is also well known in France and Germany.

Description.

Sawfly.—The adult sawfly is not quite a quarter of an inch in length, and has a wing expanse of about half an inch. Its body is blackish ; its wings are dusky, with traces of a dark band across them, but they are slightly paler at the tip ; its legs are also dark.

Larva.—The larva is at first white, but in a day or two it becomes green, and soon afterwards a dark green slime exudes from and covers its body. This exudation is evidently designed to protect the insect from parasites, and from the influences of the weather, to which it is fully exposed upon the upper surface of the leaf. The larva is particularly ugly at this period of its life, being slimy and dark green or almost black, the under part of the body paler ; while its head and the upper part of its body are much broader than the lower part, which tapers towards the end. At this stage it very much resembles a malformed slug or a tadpole. It has seven pairs of "sucker" feet on its abdomen, three pairs of distinct feet upon the thorax, and a pair of very rudimentary "sucker" feet at the end of its body. But with all these feet it moves very slowly, being slug-like in its movements. When it is full grown it is close upon half an inch in length, and at about the end of a month, after five moults or castings of skin, it loses its slug-like appearance and slime, and assumes an orange yellow or buff colour.

Life History.

The adults usually make their appearance early in June, but sometimes in May. The female soon proceeds to make an irregular oval slit in the leaf with the aid of her peculiar saw-like apparatus, which resembles that of the gooseberry sawfly (*Nematus ribesii*) and many other sawflies. In this abrasion an egg is deposited ; this can be easily seen on the leaf, as a slight, round spot is formed, in the centre of which there is a transparent skin or film covering the whitish egg. The number of eggs upon one leaf often amounts to twenty or even more, but as a rule

not more than five or six larvæ, usually only one, are seen upon a leaf. The egg is always laid from the under surface of the leaf.

The larva hatches out in from seven to twelve days, and emerges from the upper surface of the leaf. It feeds voraciously, and when full grown crawls down the tree, or falls to the ground, where it develops into a dark-coloured pupa in a little cell made of silk and earth. There are two or more broods during the year. The pupal stage lasts two weeks during the summer. The winter is passed in the larval stage in a case of earth beneath the trees, the grub pupating in the spring. The larvæ are found upon the leaves of fruit trees even as late as October.

Preventive and Remedial Measures.

1.—As it is clear that the pupæ of this sawfly are in the earth immediately under the fruit trees upon which the larvæ have been feeding, it is desirable to dig the ground all round the trees in the early spring, and to hoe it with pronged hoes so that the earth may be broken up finely. Quicklime should then be put on and hoed in.

2.—In gardens, after the digging and hoeing, it would be useful to beat down the earth in the spring with a shovel in order to prevent the flies from coming up.

3.—Soot and lime should be scattered evenly and in moderate quantity under the trees in autumn, as it has an injurious effect upon the larvæ when they fall to the ground.

4.—In the late autumn or winter poultry might be penned round trees that have been severely attacked in gardens and orchards.

5.—The removal and burning in winter of the surface soil below such trees has been proved a useful measure.

6.—Paris Green has been used as a remedy for these slug-worms. It poisons their food, and is used extensively in the United States for attacks of the sawfly larvæ and many other insects. It should be obtained in the form of paste and be applied in the proportion of 1 lb. of Paris Green to 200 gallons of water, carefully mixed and distributed over the leaves as evenly as possible. The paste can be much more easily mixed with water than the powder, which is so fine that the least breath of air blows it over the face and clothes of those who use it.

7.—Other useful insecticides are hellebore wash and arsenate of lead. These are employed as follows:—

(*a*) Hellebore wash.—1 oz. of fresh hellebore, 3 gallons of water, 2 ozs. of flour. This must be constantly stirred.

(*b*) Arsenate of lead.—This should be obtained in the paste form, the proportion recommended for use being 2 lb. to 50 gallons of water or two even teaspoonfuls to a gallon of water, the whole being thoroughly mixed.

These washes are poisonous, so must not be used on ripe or ripening fruit for four weeks before it is gathered.

These remedies would be applicable to pear, apple, plum, and damson trees. It would be more difficult to apply them to cherry trees, as the fruit is often nearly ripe when the attack of the insect is first noted. After the cherries are picked the trees should be dressed to prevent the larvæ from devouring the foliage and weakening the trees for the next season.

Heat and drought are, without doubt, favourable to the multiplication and destructive activity of this insect, while cool, showery weather interferes not only with the hatching of the eggs, but also with the growth and health of the larvæ. It is generally found that the larvæ do not cause serious harm in wet seasons.

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Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Destruction of Charlock.

This weed, which is common in cultivated fields throughout the whole of Great Britain, is known under a variety of names, such as karlock, yellows, yellow weed, skellock, runches, wild mustard (*Brassica Sinapis* Vis., *B. Sinapistrum* Boiss., *Sinapis arvensis* L.). In general appearance it closely resembles the turnip, to which, in fact, it is very nearly related. As in the case of other plants of the same family, charlock seed contains a large amount of oil, and this is at least partly accountable for the persistent vitality often exhibited by this seed. Land that has been under grass for many years may thus, when broken up, show an abundant growth of this weed, and the same state of things not unfrequently attends extra deep cultivation, and the consequent disturbance of dormant seeds.

Everything considered, charlock is perhaps the most troublesome weed with which the farmer of arable land has to contend. In corn crops its growth is often so rank as to seriously reduce the yield of grain. In root and bean crops the weed can be more easily dealt with ; but here also it often proves very injurious, and especially so when the conditions of the weather, or scarcity of labour, prevent its timely eradication. As a rule it is not conspicuous amongst rotation grasses or clover, and it is practically absent from permanent grass land.

The injury induced by charlock is partly direct and partly indirect. It competes with crops for light and air ; that is to say, it overgrows more or less completely, and smothers, other plants with which it is associated. It also robs crops of a part of their nutriment, and prevents their deriving full benefit from the moisture of the soil. But in other ways—though more indirectly—this weed may be the cause of much loss. The turnip "fly," for instance, would be unable to exist in early summer, when the cultivated crops on which it preys are, for the most part, absent from our fields, did it not find weeds like charlock to supply it with food ; and similarly the turnip-gall weevil is often found in the roots of

charlock. Then, again, the microscopic fungus that causes finger-and-toe finds a congenial habitat in the roots of this plant, which may thus do much to carry the disease over the years that separate two turnip crops.

In the case of root crops reasonable attention in the matter of horse and hand hoeing may usually be depended on to keep charlock in check. It is when present in spring corn crops that it is most troublesome. Various expedients have been tried with the view of curtailing the development of the weed. If the field be harrowed, and the sowing of the grain be somewhat delayed, a large proportion of the charlock seed will be induced to germinate, and the resulting plants may be afterwards destroyed by harrowing. Hand and horse hoeing may be practised—providing the corn has been drilled, and has not been sown down with grass or clover seeds. At a later stage of growth the flower heads may be more or less effectively knocked off by means of a special machine, the use of which diminishes the formation of seed, but does little to mitigate injury to the corn crop immediately concerned.

In 1897 attention was called to the possibility of getting rid of charlock in corn crops by means of the application of certain solutions which, it was contended, could destroy the weed without injuring the cereal. The reason for this "selective power" of such solutions is said to lie in the fact that the leaves of charlock, being rough and horizontally disposed, catch and retain the poison, whereas the leaves of cereals, being erect and smooth, allow liquids to run off, and so escape injury. During the past few seasons this method of dealing with the pest has been extensively tested in Great Britain, and, as a whole, the results have been successful. The substances chiefly tried have been copper sulphate and iron sulphate, and good results have been got with both. Although the former costs much more than the latter, the solution of iron sulphate must be used so much stronger than the other that the difference in the cost of material is less per acre than would at first sight appear. Moreover, copper sulphate deteriorates less by keeping, is more easily manipulated, and does less injury to the clothes of the workmen.

Experience indicates that good results will, as a rule, be got by dressing an acre with, at most, 40 gallons of a 4 per cent. solution of copper sulphate, or with a similar quantity of a 15 per cent. solution of iron sulphate. To make the former, dissolve 16 lb. of copper sulphate, in 40 gallons of soft water; while, in the latter case, 60 lb. of iron sulphate are required in a similar quantity of water. Somewhat better results will be got by dressing an acre with 16 lb. of copper sulphate dissolved in 60 gallons of water—

thus making a $2\frac{2}{3}$ per cent. solution—but although this entails no extra outlay for material, it implies an increased expenditure on account of labour. Then, again, in place of applying 40 gallons per acre of a 4 per cent. solution at a single operation, superior results may sometimes be got by applying 30 to 40 gallons per acre of a 2 per cent. solution at a somewhat early stage of the growth of the weed, and a similar quantity ten days or a fortnight later. As compared with a single dressing this involves no extra expenditure on material, but it entails the application of about twice as much water, and the crop suffers more from mechanical injury. Good results have occasionally been got with weaker solutions and with smaller quantities than those indicated, but on the whole those recommended above have proved most effective.

The quantities indicated have been found to do no permanent harm to cereals, or to clover or grass occupying the ground along with the corn crop, but solutions for application to beans or peas should be considerably weaker than those used for corn crops.

A convenient method of procedure is to have two 40-gallon barrels in use, so that while the contents of one are being distributed, the other may be used for the preparation of a fresh quantity of solution.

It may be noted that certain weeds closely allied to common charlock—especially wild radish, or white charlock, and smooth-leaved charlock—are not unfrequently met with, and these do not readily yield to treatment. Other weeds such as docks and thistles are more or less crippled, without being destroyed by the solutions.

To obtain the best results it is necessary to attend to the following points :—

1. The weed should not exceed three inches in height at the time of spraying, though fair success has sometimes attended treatment almost up to the time of flowering.

2. The solution must be made with clean, and, if possible, soft water, and the vessels used in the process should be of wood.

3. The material, especially copper sulphate, should be bought under a guarantee of purity of 98 per cent. It should be obtained powdered, not in crystals. This facilitates solution.

4. The solution must be applied by means of a machine that generates a fine spray under air pressure. A hand machine of good construction will dress three or four acres in a day, while a horse machine will cover nearly ten times as much. The latter distributes the solution more thoroughly and equally.

5. Rain immediately after spraying will interfere with success, and the calmer the weather the more evenly and effectively is the solution distributed. Moderate dampness of the crop at the time of spraying is no disadvantage, and better results will be got in dull weather than in bright sun.

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BOARD OF AGRICULTURE AND FISHERIES.

White Root Rot.

(*Rosellinia necatrix*, Prillieux and Delacroix.)

The destruction of fruit trees due to rotting of the root, caused by fungi, is very prevalent, and has been recorded from every part of the world where such trees are cultivated. Wild trees such as cherries, crabs, bullace, &c., growing in woods and hedgerows are also attacked, and in some instances it has been proved that the disease has passed from such wild trees to cultivated plants.

Although the disease has been mostly observed on fruit trees belonging to the order *Rosaceae*, it is by no means entirely confined to such. In Germany it has been met with on the roots of vines, fruit-trees, potatoes, beans, beet, young maples, oaks, beeches, pines and spruces. It also attacks and destroys very many kinds of weeds, and by thus being able to obtain food from the living roots of such a varied assortment of plants, the fungus when once introduced into a district spreads with great rapidity in every direction, travelling from root to root. As the fungus remains entirely underground during its progress, the true cause of the disease is in many instances not suspected.

The earliest indication of the disease is the wilting of the leaves; in the case of annual plants this is followed by the drooping of the stem, after which the plant quickly dies. If the root is examined at this stage it will be found to be covered with a white fluffy coating of fungus spawn or mycelium. This mycelium does not appear able to obtain food from a dead root, but white strands spread in all directions in the soil in search of other living roots.

When the root of a fruit tree is attacked, the end is not so sudden, but quite as certain, if proper treatment is delayed. During the first year of attack the wilted foliage falls early in the season, resulting in imperfectly matured wood.

1. A diseased root showing mycelium ascending the trunk under the bark.
2. Fruit of fungus on portion of a dead root.

During the second season there is usually a profusion of blossom with only a scanty development of foliage, which again wilts and falls to the ground quite early in the season. The fruit does not set, and the whole tree presents a distinctly sickly appearance. In the third year of disease the tree usually dies.

If the soil is carefully removed from the root of a diseased tree, patches of variable size of a snow-white mycelium will be observed on its main branches, and if the tree has been diseased for some time, white strands of mycelium will be found spreading in all directions in the soil, which has a strong mouldy smell.

If the bark of the lower part of such a diseased stem is removed, these flakes of mycelium will be found between the bark and the wood, and spreading up the trunk from the diseased root.

Two or three kinds of fungi, in addition to the one named above, cause root-rot; the general appearance of the disease and the treatment is the same for all.

During the early stage of the disease the mycelium is snow-white, eventually becoming grey in colour, especially where it grows round the collar of the trunk, or on portions of roots exposed to the light.

Various simple forms of fruit are produced by the fungus while the tree it is attacking is yet alive, but it is only after the tree is dead and its wood thoroughly dry and decayed that the highest form of fungus fruit, under the form of dense clusters of minute, black, bead-like bodies, is produced.

Preventive Measures.

If wilting of the leaves suggests root-rot, an examination of the root should be made at once; if white mycelium is found, as much of the root as possible should be carefully exposed, and the branches covered with powdered sulphur; some of this substance should also be mixed with the soil used for filling in, which should be fresh and free from mycelium, and not the old infected soil removed from the root. The infected soil should be sterilized by mixing with quick-lime or gas-lime.

Diseased trees or portions of a diseased orchard should be isolated by digging a narrow trench about a foot deep round the infected part. This prevents the underground spread of

the fungus to adjoining healthy trees. The removed soil should be thrown on to the diseased area inside the trench.

Stagnant water in the soil favours the disease, good drainage is therefore requisite.

Weeds of all kinds should be kept down, and if the disease is noticed amongst wild trees, blackthorn, bullace, cherry, &c., the trees should be isolated, removed and burned.

It is very important to collect all fragments of roots from the soil when diseased plants are removed, and to sterilize the soil.

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BOARD OF AGRICULTURE AND FISHERIES.

The Small Ermine Moths (Genus *Hyponomeuta*).

H. padella, L.

Moth, twice natural size; larvæ and web about natural size.

Identification.

The genus *Hyponomeuta* belongs to the *Tineina*, a group of small moths. The genus, though containing a small number of species, is widely distributed. There is considerable confusion in the literature, in the description, and in the naming; the confusion arises from the fact that (1) both the moths and caterpillars of the different species have a great resemblance to one another; (2) the caterpillars of more than one species may be found on the same food plants; and (3) the separate life histories are very much alike.

Generally it may be said that the moths are small, their fore wings are white or lead-grey or slate-coloured, with black dots (hence the name Ermine Moths); and the thorax has usually also similar marks. The hind wings are darker in colour and have long fringes. The caterpillars live together socially on the twigs in gauze-like spun webs, and under cover of these webs pupation takes place in cocoons shaped like oat grains.

The caterpillars of two or three species are destructive to the foliage of the Spindle tree (*Euonymus europaeus*, L.), and in addition in Britain there are three species harmful to fruit trees, viz., *Hyponomeuta padi*, Zell. (*H. euonymella*, L.), whose caterpillars feed chiefly on bird cherry; *Hyponomeuta padella*, L. (*H. variabilis*, Zell.), whose caterpillars feed on plum, hawthorn, sloe, medlar, apple, mountain-ash and other *Pyrus* species; and *Hyponomeuta malinella*, Zell., whose caterpillars feed on the apple.

H. padi. This moth is the largest of the three. It measures 9 mm. in length (roughly, there are 25 millimetres in an inch) and 25 mm. in stretch of wings. The head is white, and the upper surface of the fore wings is also white with five longitudinal rows of black dots. The hind wings are dark grey. The caterpillars are yellowish in colour, with black heads, and may measure when full grown 20 mm.

H. padella measures 8 mm. in length, and 22 mm. in stretch of wings. Head white; fore wings white-grey with four longitudinal rows of black dots, a small number in the lowest row; hind wings dark grey with pale grey white-tipped fringes; the abdomen ash-grey with whitish rings. The caterpillars have black heads, they are greyish in colour with conspicuous dark-coloured spots, and measure 14 mm. in length. The pupa is yellow in the middle, the head and wing-cases are black-brown, and the cocoons, which hang singly in the web, are very delicate.

H. malinella is 7 mm. long, and 17 mm. to 19 mm. in spread of fore wings. The fore wings have four longitudinal rows of black dots; the hind wings are dark grey with the fringes pale grey. The caterpillars have black heads and are yellowish in colour, with slight variations at different ages. The cocoons are not delicate as in *H. padella*, but they are opaque and hang together in bundles.

Life-History.

The moths are found flying in July and August, and the eggs are then laid on twig and bud in larger or smaller collections. The eggs lie under cover of a glutinous substance which dries into a protecting case. They may hatch in the autumn of the same year, but the caterpillars, on account of their small size, are not noticed. They do no damage until the next spring when they may enter buds, feeding on the blossom and mining into young leaves. Soon attaining strength, in May and June the caterpillars feed externally on the leaves and spin their webs. The web-making continues as the larvæ move to fresh feeding places. The feeding caterpillars are social, living together in numbers in a web or nest.

In cases of bad attacks the trees may be almost stripped of foliage, and rendered unsightly by the dirty coloured ragged

webs. The caterpillars when full-fed become pupæ in cocoons, a number of these being present in a web; the pupal stage lasts a fortnight.

Infested trees are greatly weakened by the loss of foliage, and although after the caterpillars have stopped feeding the trees produce a fresh set of leaves, there is bound to be shortage of the fruit crop. In the case of the apple the young fruits fall away when the foliage is stripped.

Preventive and Remedial Measures.

1. The moths may be shaken down from the trees on which they rest during the day, on to cloths spread below to catch them. The moths are sluggish and rest with their narrow wings rolled round the body.

2. Handpicking (if practicable) and cutting off of infested twigs should be practised, the webs being crushed or burnt in order to kill the contained brood.

3. If water under high pressure from a hose can be applied the colonies may be effectively destroyed.

4. Spraying with paraffin emulsion, or an arsenical spray. The earlier this is done the better, before the webs become so numerous or so thick as to protect the leaves from the wash and prove difficult to penetrate. The Board know of one case in Perthshire where, in an extremely severe infestation, the proprietor, dissatisfied with the result of a paraffin spray, made up a strong solution of an arsenical sheep dip, and by this means killed thousands of caterpillars. The caterpillars that had not been killed, or which on disturbance had let themselves down from the web by their threads, collected at the foot of the trees and were easily destroyed. Great care, however, had to be exercised, as any leaves touched by the material turned black and dropped off.

4, Whitehall Place, London, S.W.
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BOARD OF AGRICULTURE AND FISHERIES.

Fowl Cholera.

Fowl cholera is a contagious disease of birds due to the bacillus of fowl cholera, which frequently appears on the Continent of Europe and in America, and is by no means rare in Great Britain.

Birds Susceptible.

The disease may attack fowls, turkeys, geese, ducks, guinea-fowl, pigeons, pheasants, partridges, and some of the smaller wild birds. It is also communicable to rabbits by inoculation.

The Microbe.

Fowl cholera is caused by a minute ovoid bacillus, which is found in the blood, organs, and intestinal contents of birds suffering from the disease. The bacillus does not form spores ; it is easily destroyed by disinfectants, and it gradually loses its virulence on exposure to air.

Methods of Infection.

Birds are infected by eating food-stuffs, or drinking water, which have been soiled by the excrement of infected birds.

The disease may be brought into a flock by newly purchased birds, by birds returning from poultry shows, by dealer's crates, and by birds which have recently occupied dealer's crates, or by utensils soiled by affected birds, or by wild birds which are susceptible to the disease. The infective excretions may also be carried on the boots of people who have visited affected flocks.

There is reason to believe that birds which have recovered from fowl cholera may remain infective to others for a considerable time.

Symptoms.

The disease has a short incubative period (eight hours to three days) and the mortality is high. In the most acute cases the onset of the disease is so sudden that symptoms of illness are often not observed, and the birds are found dead. In less acute cases there is loss of appetite and great thirst, erection of the feathers, drooping of the head, wings and tail, swaying gait, quick breathing, and great depression.

Diarrhœa is a most noticeable symptom. The evacuations are frequent, watery, white or yellow at first, becoming green and fœtid as the disease progresses. The feathers round the anus become matted together. A whitish discharge flows from the eyes, nose, and mouth. The comb and wattles at first are paler than normal, but later they become of a livid colour. This form lasts two or three days, when the birds usually die in a state of stupor, or in convulsions. The death-rate among affected birds may be from 80 to 90 per cent. Towards the end of an outbreak milder cases occur, and a greater number of recoveries takes place. Birds which recover acquire a certain amount of immunity to this disease, and, if they thrive, are valuable for re-stocking purposes.

Post-mortem Appearances.

In acute cases the only lesions visible to the naked eye will be found in the intestinal tract. The intestinal contents are watery, whitish in colour, but sometimes blood-stained. In the intestinal wall, and particularly on the mucous membrane, bloody patches are seen. There are also areas of congestion, ranging in colour from red to purple and black. The mucous membrane is destroyed in places and patches of yellow exudate may be observed. The liver and spleen are usually engorged, and in some cases the lungs are consolidated.

Preventive Measures.

1.—An endeavour should be made to prevent the introduction of the disease by isolating all newly purchased birds and birds returning from poultry shows for fourteen days, unless there is some guarantee that they have not been in contact with infection.

2.—Crates, utensils, etc., which have been used for suspected birds should be disinfected.

3.—If any attendants have been in contact with diseased birds, their hands, clothes and boots should be disinfected before they go near healthy birds.

4.—If the disease appears, all suspected or affected birds should be isolated, and the healthy ones should be moved to fresh ground.

5.—The houses, nest boxes, utensils, and the parts of the runs contaminated by the affected birds, should be thoroughly cleansed, and disinfected with 5 per cent. of carbolic acid in water, or with a 2 per cent. solution of commercial sulphuric acid in water. The houses should then be lime-washed, using a wash in which $\frac{1}{4}$ lb. of carbolic acid has been mixed with each gallon of wash.

As it is impossible to disinfect fowl runs thoroughly, it is not safe to re-stock infected runs with fowls, turkeys, geese, ducks, or guinea-fowl for two months after the disappearance of the disease.

6.—Dead birds and their excreta should be burned, or buried deeply, and covered with lime.

A protective serum is sometimes used on the Continent, but it is expensive and its value is doubtful.

4, Whitehall Place, London, S.W.,
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Re-written, July, 1911.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 19 leaflets dealing with Poultry and Bees, their Breeding and Management, may be obtained from the same address, price 1d., or 9d. per dozen copies, post free.

BOARD OF AGRICULTURE AND FISHERIES.

Favus or White Comb in Poultry.

While many fungi cause disease in plants some give rise to disease in animals. Ringworm and Favus are two such diseases, the disease-causing fungi consisting of extremely delicate threads which prey on the live tissue of the host.

The disease Favus in the fowl is due to a parasitic fungus, *Lophophyton gallinæ*, which is distinctly different from that causing favus in mammals. This fungus attacks the comb and wattles of birds, and spreads from the naked parts of the head to parts covered by feathers, *e.g.*, the neck, and the parts in the neighbourhood of the cloaca. Sometimes one side only of the neck may be affected, becoming quite deplumed, whilst the other shows no signs of invasion; but, as a rule, it is the comb that suffers first and most from the attack. Favus may spread to man, rabbits, and mice, but dogs and rats are unaffected when inoculated. The disease is rarer in Great Britain on man than it used to be, and is almost exclusively confined to the poorer classes where conditions have been dirty and insanitary.

Favus is very destructive in poultry-yards, and, being highly contagious, often spreads with great rapidity. A single diseased cock soon contaminates the whole run, and several outbreaks have been traced to a new male bird from an affected yard.

Nearly all breeds seem equally susceptible, but the disease does not appear to have occurred in Indian Game; it is said that fowls of Cochin China descent are most liable to it.

Symptoms.

The first signs of an attack of favus are small, pale, irregular, cup-like spots on the comb or wattles, generally appearing on the comb first. These spots grow together, and sooner or later form a confluent covering of a dirty yellowish-grey substance, which is often arranged in concentric layers. These crusts grow thicker. When they are present on the comb or wattles there may be a complete and rapid disappearance of the malady; but when the feathered areas become invaded the disease is more persistent. The feathers become erect, dry, and somewhat brittle, and fall off; the breast sometimes, and the rump especially, may be denuded by the fungus, which, when present on the feathered parts, may end fatally unless treatment is resorted to. On the feathers falling off the naked skin is left covered with dull yellowish grey crusts, showing here and there somewhat funnel-shaped depressions from which the feathers have fallen. The affected birds exhale a mouldy odour.

The fungus may easily be observed by scraping the diseased surface or the skin under the crusts, and examining the scraping under a microscope. It will then be seen to consist of a number of fine threads (the mycelium). To examine the fungus, the scraping from the skin and crusts should be put on a slide, and then moistened with distilled water and a little acetic acid.

Care should be taken in handling patients, as the disease can be transmitted to man. The fungus has powers of penetration, but far the greatest risk of infection is run if the skin or surface is abraded or wounded.

Treatment.

1.—The treatment consists in bathing the invaded parts with warm water and soft soap, and then applying some ointment to destroy the parasite. Nitrate of silver well rubbed into the comb and wattles has been found of great benefit. A correspondent of the Board of Agriculture and Fisheries recommends an ointment of 5 per cent. of nitrate of silver in soft paraffin (vaseline) for the purpose. Red oxide of mercury one part, to lard eight parts, has proved an excellent remedy if used for several days.

2.—Foment the diseased parts carefully before applying the ointment, and remove as far as possible all the favic crusts with a blunt knife.

3.—One cannot be too careful in examining a fresh bird before turning it into the run, where it should not be allowed if any signs of "favus" are noticed upon it.

4.—Should the disease appear, infected birds must be isolated, or they may spread the disease. They should be treated at once, as when the parasite reaches the feathered tracts it is much more difficult to eradicate.

4, Whitehall Place, London, S.W.,
March, 1901.
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BOARD OF AGRICULTURE AND FISHERIES.

Currant Aphides.

Now and again currant bushes are considerably damaged by Aphides or Plant Lice. In some districts the bushes are quite ruined, the leaves turn brown and shrivel up, and the fruit falls off, the bunches "shanking" in consequence of the abnormal presence of these pests. The rapid increase of the "Plant Lice" is due to a long spell of dry, warm weather, so favourable to the development of these insects, so detrimental to the development of the fruit and health of the bushes. Aphides are usually more or less prevalent on currants, and are always liable under certain favouring climatic conditions to increase to an injurious extent. Currant bushes should therefore be washed early in the year just as regularly as apple, plum, and pear trees. Of species of Aphides occurring on the genus *Ribes*, there may be mentioned the Currant Blister Aphis (*Rhopalosiphum ribis* of Linnæus), *Myzus ribis* of Linnæus, and the Currant Root Aphis, *Schizoneura fodiens*, Buckton.

Theobald* has found *Aphis grossulariae*, Kalt., harmful on red currants and gooseberry, causing the top shoots to become dwarfed and the leaves curled up in a tight mass.

Leaf Aphides.

The first two aphides live above ground and work in a slightly different way. One, *R. ribis*, produces reddish, reddish-brown, or yellow blister-like galls on the surface of the leaves, whilst *Myzus ribis* often causes the leaves to curl up, especially on the top shoots. Both species are equally difficult to destroy after they commence to breed in numbers, owing to their being hidden, and more or less protected in the hollows of the blisters and under the curled-up leaves. The galled patches are chiefly noticed on the upper surface of the leaf, where they are blister-like ; below they are concave. In the cavity the Aphides live and breed, increasing the area of the diseased patch as they develop. Numerous blisters may be formed on one leaf, varying in size from one-fourth to nearly an inch in length. The leaves so attacked shrivel away, but the fruit

* *Journal of the South Eastern Agricultural College*, Wye, 1909, p. 125.

often falls, owing to loss of sap, long before the leaves die. It is stated that neither of these Aphides forms much "honey-dew" at first, hence the diseased appearance of the leaf is often not noticed as being of insect origin during the early stages of the attack unless an examination has been made of the under surface. Later on "honey-dew" becomes abundant, being especially formed by the leaf-curling species; on black currants the "honey-dew" often gives a shiny and sticky appearance to the whole bush.

The insects spread chiefly by means of winged generations, which appear every now and then, flying from bush to bush, and there setting up fresh areas of disease. These winged generations may occur as early as the middle of May, but usually not until June.

Life-history.

The appearance and habits of *R. ribis* and *M. ribis* are different, but their life-histories are very similar.

(I.) *Rhopalosiphum ribis*, L.—The wingless viviparous female, or "Mother Queen," is shiny green, mottled with darker green; the legs, honey-tubes, and antennæ are pale green; and the eyes red. In form it is oval and convex, and slightly larger than *Myzus ribis* (II. below), the body being one-tenth of an inch long. The wingless females are found on the under-surface of the leaves and cause the red, orange, and yellow blisters. They appear first of all in April, and occur continuously until July and even August. Every now and then the lice to which they give rise turn into so-called pupæ which are characterised by rudiments of wings appearing as wing buds.

The pupa is green, and does not, apart from the wing cases, differ much from the wingless female or larva. The winged viviparous female, which arises from the pupa, is yellowish-green with black head and antennæ; the thorax is black with a yellow band in front; the abdomen is bright yellowish green, with dark spots and patches on the back and sides; the honey-tubes are yellow, and swollen towards the apex; and the legs are ochreous, with the joints and feet black. These winged females fly from bush to bush. In the autumn or late summer males and egg-laying females are formed; the egg-laying female, after being fertilised, deposits a few brown elongated eggs on the last year's growth of a twig just under the broken rind or upon it. Here the eggs remain all the winter. This aphis, besides feeding on the red, black, and white currant, also attacks the gooseberry, and has been found on the Guelder Rose, Nipplewort, and Sow Thistle.

(II.) *Myzus ribis*, Linn.—This plant-louse can easily be distinguished from the former, with a lens, by its olive, not

black, head, and its black honey-tubes and irregularly black ornamented abdomen in the winged female. It occurs from April to August, especially on the black currant and gooseberry, but also on the red currant ; it is said to cause blisters similar to *R. ribis*. It often causes the leaves at the apex of the shoots to curl and twist up.

The wingless female, which appears in the spring, is shiny yellowish-green, with dark green mottlings, elongated oval in form, and with curious hairs in front ; the honey-tubes and legs are pale green, and the eyes bright red. The larvæ are pale green. When the leaves lose their sap, the larvæ turn to pupæ, and then to winged females. The pupa of this species is shiny yellowish-green, with two brown spots on the back of the head. The winged viviparous female is bright green, with pale olive head, brown thorax with an olive band across it, irregular transverse bands and spots on the abdomen, and four or five dark lateral spots ; the deep olive-green to black honey-tubes are cylindrical in form, and the deep green legs have olive feet. Towards July many leave the currants, but, as in the former species, some always remain, and give rise to egg-laying females and males, the former depositing their long brown eggs under the exfoliated rind, attaching them to it by a gummy excretion ; the eggs hatch in the spring, when they give rise to larvæ, which soon grow into the "Mother Queens." The wingless female is smaller than in the former species, being little more than one-twelfth of an inch long. It also occurs on the gooseberry, and it has been noticed to curl up the leaves and deform the shoots more often than the former species.

Natural Enemies.—The larvæ and adults of the two-spotted Lady Bird are often to be found feeding amongst the colonies of lice, and do inestimable good in keeping them in check. Larvæ of several species of Hover Flies also feed on them, their leech-like green or dull red larvæ living amongst the lice in the blisters or curled leaves.

THE CURRANT ROOT APHIS.

(*Schizoneura fodiens*, Buckton.)

This Aphis, which infests the roots of black and red currants, is mentioned by Buckton in his Monograph, and has been recently recorded by Theobald in England and Carpenter in Ireland. It is recognisable by the woolly fibrous material which covers the insect, as it does the Schizoneura of the apple. The life history of Aphides is often complicated by migration and the spread to other plants. In the recent literature it has been determined that *S. fodiens* is not a separate species but a stage in the life history of *Schizoneura ulmi*, an enemy of Elm, the leaves of which are blistered and rolled by the punctures of the sheltering Aphides.

Danger attends the spread of this insect, and Theobald recommends the examination of young stock before planting. Where the woolly material is observed the roots of the plants should be dipped in a warm mixture of soft soap, quassia, and water.

Prevention and Treatment.

1.—After an attack black currants should be cut very hard in the autumn, the strippings being carried away and burnt. By doing this many eggs will be destroyed. Probably some benefit would be derived by the winter washing with caustic alkali wash (*see* Leaflet 70), the bushes being sprayed about February.

2.—When Aphides are present on the bushes it is most important to *spray early in the year*, directly the lice are seen, that is before the blisters appear or the leaves become curled up ; the lice can then be far more readily reached by the spray than later in the year.

Various sprays which are of service against Aphides, and treatment against root infesting forms, are mentioned in the Leaflet on Aphides, No. 104.

3.—The development of plant lice is favoured by dry and hot weather, and swilling with ordinary water is always beneficial in such conditions.

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Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 22 leaflets dealing with Insect and other Pests injurious to Fruit Trees and Bushes may be obtained from the same address, price 1d., or 9d. per dozen copies, post free.

BOARD OF AGRICULTURE AND FISHERIES.

TENT CATERPILLARS.

The Lackey Moth (*Clisiocampa neustria*, Linn.) *and* the Brown Tail Moth (*Porthesia chrysorrhœa*, Linn.).

Two species of so-called "Tent Caterpillars" are frequently found on various fruit trees, especially on the apple, plum, and pear. By far the commonest and most destructive of the "Tent Caterpillars" is the Lackey Moth Caterpillar (*Clisiocampa neustria*). In some parts of England, however, notably certain districts in Kent, the somewhat local Brown-Tail Moth (*Portnesia chrysorrhœa*) does almost as much harm in some seasons. In parts of Kent the caterpillars have in some years done considerable damage to apple and plum orchards. The caterpillars of both moths are called "Tent Caterpillars" on account of their forming tent-like nests of silk on the trees, in which they live during their early existence, and beneath which they shelter during wet weather and at night when they are more mature.

The damage caused by the larvæ can easily be prevented, and even when they have a considerable hold on the orchard they can be dealt with and to some extent be destroyed by spraying.

As there is some difference in life-history as well as in appearance between the two species, they are best considered separately as far as their natural history goes; prevention and treatment are the same for both species.

I.—The Lackey Moth.

Distribution, and Trees attacked.—The Lackey Moth is widely distributed over the south, west, and middle of England, but is far more abundant and destructive in the south and west than in other parts. It does not occur further north than York, where it is usually rare. Always more or less prevalent in the south, at certain times it occurs in greater abundance, and apple and pear orchards are sometimes stripped of every vestige of foliage by the caterpillars. It is abundant in France, where there are laws compelling growers to cut off and destroy the "tents" formed by the larvæ. The "Lackey" larvæ feed also on oak, elm, hawthorn, and many other trees and shrubs.

Description.

The moth is very variable in colour and size, and measures up to an inch and a quarter in expanse of wings in the male, and an inch and a half in the female. The fore wings are a rusty reddish-brown, yellowish-brown, ochreous or brick-dust red, with two pale or dusky brown transverse lines across them, the space between the two bars being often more deeply coloured than the rest of the wing; the hind wings are the same tint as the fore, but often a little paler; the thorax and abdomen are densely scaly. The adult may be taken on the wing at dusk in July and August, and even as late as September.

The eggs are deposited in autumn in rings that surround the smaller shoots of the fruit trees, each ring containing from forty to over two hundred eggs. These remain unhatched on the trees all the winter, and, being greyish-brown in colour, are readily seen by a careful observer on the dark ground-colour of the twigs.

The caterpillars are almost black at first, and more or less hairy.

They become brilliantly-coloured as they grow, being bluish-grey, with two black spots on the segment next the head, and two also on the bluish-grey head; there are three orange-red stripes along each side, and between the two lowest of these is a broad blue stripe with little black specks, these brilliant lines being separated by black and black spotted with blue, and a white stripe down the back with a narrow black line on each side; the whole larva is covered with rather rusty hairs, darker above than at the sides. When full-grown the caterpillar reaches two inches in length.

Life History.

The eggs hatch about the end of April, and the young larvæ soon commence to form a fine web, enclosing a few leaves, and beneath this little tent of silk they continue to feed in communities for some time. As they grow the silken house is enlarged, until in some large colonies it may reach nearly a foot in length. At first the larvæ feed entirely under the tent, but as they grow they spread out over the trees, and eat off the leafage and blossom, returning to the web at night and in wet weather. On warm days they may often be found in batches, several lying parallel with one another, either on the outside of the tent or along the branches. They are somewhat timid, and fall to the ground on the tree being shaken, but soon crawl back to the foliage again. From the middle of June to the end of July they reach maturity, and spin a delicate loose white cocoon, the silk being mixed with a yellowish powder and numerous hairs of the larvæ. The cases are formed amongst the leaves, on the bark, amongst grass below the

THE LACKEY MOTH.

(A) Tent and caterpillars. (B) Male moth. (C) Egg-ring (natural size). (D) Pupa (natural size).

trees, on walls, fences, &c.; always above ground. The larva changes in this cocoon to a dark-brown pupa, from which the moth emerges in from two to three weeks.

II.—The Brown-Tail Moth.

Distribution, and Trees attacked.—According to Stainton the Brown-Tail Moth is local, and not to be found everywhere. Where it does occur, however, it is often very abundant. It is recorded from Lytham, Epping, Teignmouth, Lewes, Lymington, Stowmarket, Black Park, Chesham, Dorking, Newhaven, Bisterne, Bristol, Norwich, and many other places; it has also been recorded from Scotland; it is always more or less abundant in various parts of Kent; in 1907 it was sent to the Board from Cheshire, and in 1908 from Burnham-on-Crouch.

The female lays her eggs on the under surface of the leaves of the oak, elm, beech, willow, rowan, black-thorn, white-thorn, apple, plum, and sometimes pear.

Description.

The female moth has pure white forewings, with a faint black spot; hind wings pure white. *The male* has similar fore and hind wings, white head, thorax and abdomen, the apex of the latter having a golden brown tuft. In length the wing expanse varies between an inch and a quarter and an inch and three quarters. The moth is a night flyer, resting during the day on walls, leaves, lamps, &c., and is then very sluggish, falling down as if dead when its resting place is shaken.

The eggs are round, of a golden hue, and as many as two hundred and fifty may be counted in each batch. Each patch of eggs is covered over by hair from the female's tail and completely hidden.

The caterpillars are at first very small, of a dirty yellow appearance, with a black head and four rows of black dots and numerous hairs. In the spring of the next year they moult and assume a deep brown appearance with reddish-brown hairs, a row of white spots on each side, a narrow double broken line of red alone on the dorsum, black between, and with two prominent bright red tubercles on the back of the eleventh and twelfth segments, depressed in the centre; these tubercles can be elevated or depressed by the larvæ at will.

The pupæ are deep brown in colour, and are enclosed in a dusky cocoon.

Life History.

The moth appears towards the end of July and in August, and eggs are laid on the under surface of the leaves. The larvæ hatch out about the beginning of August, and live through the winter. To begin with they attach a single leaf

by silk to the twig so that it cannot fall off, and eat the epidermis.

Towards September they commence to make a regular tent or nest, attaching a number of leaves together by silk. The leaves are lined and covered with silk, and all firmly united. This nest is used as a place of protection from cold and damp, and as a nocturnal shelter. During the latter part of August the larvæ moult and still feed on as long as the leaves contain any sap. Even after the leaves have fallen it is not unusual to see the larvæ on a sunny warm day basking in the sun outside the tent. As the weather becomes cold, they become dormant and remain in their dwelling. In the spring of the next year they recommence feeding on the leaves as they open, and wander freely over the trees. Very frequently the colony divides, two nests being made, and sometimes even a third is formed. Early in May they moult again, assuming the appearance described above. After this moult they spread out over the fruit trees, forsaking their nests, and then devour the foliage very ravenously.

From the end of June to the beginning of July they spin a cocoon amongst the leaves of fruit trees, as a rule several together forming a large mass united by a dusky web. In this they change to deep brown pupæ. As many as forty have been counted on a damson tree. From these pupæ the moths hatch out in the latter part of July and August, and soon commence to lay fresh eggs on the trees.

Prevention and Treatment.

1.—After an attack of Lackey Moths the orchards should be gone over in the winter and all egg-bands collected and burnt. On large trees this is not possible, but where it can be done, it is a rule that should always be followed.

The small tents of the Brown Tail should also be looked for during the winter and cut off and burnt. Any tents left should also be collected and destroyed in the early summer either on a dull wet day or during the evening, when the caterpillars are at home, or no good would be done. The tents of the Lackey should also be collected during summer. As the larvæ readily fall when shaken, care should be taken to hold boards or a sheet beneath the tents which are being cut off, otherwise little good will accrue, as the fallen Lackeys soon get back to the trees.

2.—A great deal of damage will be saved by spraying as soon as the attack is noticed, especially when the tents cannot be reached by hand. For this purpose arsenical washes should be used. Of these washes the two best known are Paris Green and Arsenate of Lead. The latter is the better wash of the two, killing the larvæ and yet not damaging the foliage, as sometimes happens with Paris Green.

THE BROWN TAIL MOTH.

(A) Male moth. (B) Female moth. (C) Summer tent and larvæ.
(D) Winter tent of larvæ.

The Paris Green should be bought in the paste form, ½ lb. being used for every 100 gallons of water.

The Arsenate of Lead should also be bought in the paste form, the proportion for spraying against the young caterpillars being 2 lb. to 50 gallons of water, the whole being thoroughly mixed.

In all cases proper sprayers must be used with fine nozzles, so that a dense mist of the wash is thrown on the trees.

Natural Enemies.—Both the eggs and the larvæ of the Brown-Tail Moth are attacked by Ichneumons.

Being hairy, these larvæ are avoided by birds, so that little help is given by the latter when the pests are causing harm in the orchard. The cuckoo is the only bird known to devour these hairy caterpillars. Two beetles destroy the larvæ of the Lackey Moth on the Continent, namely, *Calosoma sycophanta* and *C. inquisitor.*

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Leaflet No. 70.

BOARD OF AGRICULTURE AND FISHERIES.

Winter Washing of Fruit Trees, and the Treatment of Neglected Orchards.

In attempting to bring about an improvement in neglected and worn-out orchards, the most which can be hoped for is to repair to some extent the injury caused by age or neglect, or both, for it is futile to expect that any course of treatment will entirely remedy previous mismanagement. The results obtained will depend largely upon the local conditions in each case ; and while in some orchards a very considerable improvement may be looked for, in other instances the results may be somewhat disappointing. Where the orchards are prematurely worn-out, or otherwise unsatisfactory, benefit may be safely anticipated ; but where the decay is natural and due mainly to old age, it is probable that nothing short of entire re-planting will suffice.

The measures to be adopted consist in the thorough cleansing of the trees and the combating of insect and fungoid pests by means of winter washing, summer spraying, and similar treatment, together with manuring, pruning, regrafting unsatisfactory trees, and replanting.

Winter Washing of Fruit Trees.

A neglected orchard not only harbours, during the winter, all manner of insect enemies which commence their ravages in spring, but it forms a nursery or breeding ground from which other orchards are infested. The first step, therefore, is to destroy these pests as far as possible, and for this purpose winter washing is practised.

The caustic or burning wash applied clears away moss, lichen and other vegetable growths that are not only harmful to the health of the tree, but which also act as shelter places for injurious insects. The wash may also reach the insects themselves in their various stages of development.

The Woolly Aphis, the Apple Blossom Weevil, the Earwig, the caterpillar of the Codling Moth in its cocoon, and other insects, are found during the winter sheltering under cover of rough bark and of lichenous and other growths on fruit trees. The destruction of their winter quarters places such insects at a disadvantage, and their number is in consequence materially reduced. Further, some of the insects are killed by the wash itself.

It has been found in practice that a wash used with effect against an insect in its adult, larval, or pupal stage, may prove quite ineffective against the egg of the insect, and hence winter washing should be followed by careful observation in spring, so that the young newly-hatched insects may be dealt with—according to their kind—before they have had time to do great harm or to multiply.

Formula for Winter Wash.—The materials necessary for the new caustic winter wash are :—Caustic soda (98 per cent), sulphate of iron, lime, paraffin and water.

In the revised leaflet issued last year (January, 1908), an emulsion soda wash composed of paraffin, soft soap, caustic soda and water, was recommended. As a result of experiment an improvement has been suggested by Mr. S. U. Pickering, Director of the Woburn Experimental Fruit Farm, whose formula is now recommended in its place, viz. :—Iron sulphate, $\frac{1}{2}$ lb. ; lime, $\frac{1}{4}$ lb. ; caustic soda, 2 lb. ; paraffin (solar distillate), 5 pints ; and water to make 10 gallons.

In order to prepare the wash the iron sulphate should be dissolved in about nine gallons of water. The lime should then be slaked in a little water and be well stirred, a little more water being added to make a "milk." The "milk" of lime should next be run into the iron sulphate solution through a piece of sacking or a fine sieve to remove grit or coarse particles. The paraffin should then be added and the mixture churned thoroughly. Just before using, the caustic soda, in the powdered form, should be added to complete the "wash."

This wash, which has both a cleansing property and an insecticidal value, is recommended for application while the trees are dormant, and certainly before the buds have burst. Perhaps the greatest advantage would result from such a wash if applied about the beginning of February.

NOTE :—As the wash has a burning effect on the hands, care should be exercised in employing it. Rubber gloves are sometimes used to protect the hands, but these should be so secured that the wash cannot run in under the rubber. The face, the eyes especially, should also be protected.

It is advisable not to allow live stock in grass orchards for a week or two after spraying.

Effect of Caustic and Other Washes on the Health of the Sprayed Plants.—Comparatively few exact experiments have been conducted to discover how caustic washes affect the health of the plants themselves. Complaint is sometimes made that the plants suffer severely, and with constantly repeated washings this may be true. The winter wash above recommended need not be applied annually, but only at intervals of some years.

Manuring.

When fruit trees begin to bear freely it is essential, if free growth is to be maintained, that they should be regularly manured to compensate for the extra demands made upon them by the production of the crop. If left unmanured, the soil will sooner or later show signs of exhaustion, and the further development of the trees will be checked. In order that both growth and fruitfulness may continue, the tree must be able to draw from the soil the necessary amounts of nitrogen, phosphoric acid, potash and lime. A free supply of each of these substances is required, nitrogen and potash being particularly needed for the development of new growth, while phosphoric acid and lime play an important part in the production of fruit of a good quality. Lime in conjunction with potash is also of the greatest service in developing hardiness and enabling the trees to resist canker.

The extent and nature of the manuring required must be determined by the character of the soil and by the special circumstances of each case, but our knowledge as to the best forms in which to apply the various essential constituents is at present far from complete.

If it be advisable that growth be forced, nitrogen and potash should be used freely, the former especially, in a condition quickly available for the trees. Some distinction should probably be made in this particular between grass orchards and trees in cultivated ground. In grass orchards a more or less regular supply of nitrogen is provided by the stock utilising the orchards for grazing purposes, whereas in the case of tilled soil the only source of nitrogen, other than the atmosphere or manure directly applied, is the decaying vegetable matter returned to the soil by weeds and fallen leaves. In cultivated orchards, moreover, nitrification probably proceeds more rapidly than in those on grass land. In the latter, nitrogen in the form of nitrate of soda or sulphate of ammonia seems preferable to organic nitrogen; whereas organic manures may be of equal value for cultivated soil. Where nitrate of soda is used, it should be applied in the spring.

As a potassic manure, sulphate or chloride of potash may be recommended; the latter should only be used on soils rich in lime. Kainit is considered by some authorities to be unsuitable for fruit.

Phosphoric acid is generally best supplied in the form of basic slag, except where immediate effect is required, in which case superphosphate should be used and supplemented later with slag.

Lime may be applied as quicklime, slaked lime or chalk, the last being safer if it is likely to be brought at once into

contact with the delicate rootlets. As a surface dressing the other two are perfectly safe.

Lime, phosphoric acid and potash may be applied in autumn, winter or spring. In cultivated soil the manures may be applied as a surface dressing and then worked into the ground, but in grass orchards this method is slow in producing effect. To produce quicker results a series of small holes may be drilled in the ground in the neighbourhood of the young roots, or strips of turf may be temporarily removed in the same region and the manure incorporated directly with the soil. The quantity of manure required should be varied according to the size of the tree. Some time is required for the manure to make its effect visible where trees are concerned, and if no response is apparent during the first season it should not be concluded that the application has had no result.

Stock should be regularly turned into the orchards for grazing, since they are able to supply considerable quantities of nitrogen as manure. The practice of turning in pigs during the winter is useful, for they not only improve the soil by the addition of manure, but by bringing about its aeration by constant grubbing, while they also destroy many larvae and pupae of insects.

Pruning.

When young standard trees are properly pruned for the first five or six years after planting, they require very little attention in that respect later. They should be gone over each year, all surplus wood being thinned out, and interlacing or diseased branches cut away. Non-observance of this practice will result eventually in the development of a head of densely tangled and diseased branches, examples of which are to be found in nearly all old orchards. The extent to which this condition may be remedied by careful pruning depends very largely upon the individual trees. If, for example, a tree is very old, the amount of wood which ought to be cut out is generally so great that its removal seriously weakens the tree, and frequently even kills it. In dealing with old trees it is necessary that the greatest care be taken not to remove too much wood at one time. It is better to spread the operation over two or even three seasons than to cripple the trees by too severe pruning. Many full-grown trees do not lend themselves at all well to the purposes of pruning. The requisite thinning-out of the wood frequently cannot be accomplished except by the removal of many of the larger branches, with the result that a very large portion of the head, and especially of the fruiting wood, is lost. When pruning is being done, therefore, these facts should not be overlooked. As much surplus wood and interlacing and

diseased branches as can be spared should be cut out, and particular attention should be given to thinning in such a manner that the fruiting wood is exposed as far as possible to a free supply of air and sunlight. Extra time spent in removing dead and diseased twigs will be profitably occupied, for it is on such parts that some of the most serious fungoid pests, such as the Brown Rot and Apple Scab fungi, pass the winter stages of their life-history, and in the following spring break out into active growth and produce another epidemic of infection.

All prunings should be burnt immediately, in order to destroy insect and fungoid pests; the ashes should be distributed over the soil as manure.

Re-grafting.

In cases where trees of existing varieties prove to be unsatisfactory or unprofitable, they may often with advantage be headed back and grafted with more suitable sorts. Dessert varieties which may be recommended for propagation under such circumstances are Worcester Pearmain, Duchess of Oldenburg, Cox's Orange Pippin, and Alington Pippin, if the original trees are vigorous growers, while Ecklinville, Newton Wonder, Warner's King, and Bramley's Seedling are suitable culinary kinds. There is some risk in regrafting, since occasionally the operation results in the death of the tree at once, the grafts failing to develop; while at other times after apparently satisfactory growth has followed for two or three seasons the tree may suddenly die.

Re-planting.

Although the planting of young trees in old orchards is not a practice to be recommended if fresh land can be obtained, growers are frequently obliged to fill up gaps in old orchards. If the orchard concerned be composed almost entirely of old trees likely to die in the course of a few years, the young trees planted as the vacancies arise should as far as possible be placed so as to fall into proper position relatively to the young trees which will eventually replace the remaining old trees.

Where gaps are to be filled in comparatively young orchards there is not generally the same degree of choice of position available, since the existing trees may last for several years and the available area for the selection of a site is therefore restricted within narrow limits.

In any case, however, it will be well if each new tree can be planted in such a way that it will not occupy the same spot as its predecessor; and in such instances the planting may be done in the usual manner.

Where, on the other hand, a new tree will occupy the same ground as the old, special preparation of the soil should be attempted. The roots of the old tree should be first removed as completely as possible, in order that no decaying wood may be left in the soil, and a circular hole, at least six feet in diameter and from $1\frac{1}{2}$ to $2\frac{1}{2}$ feet in depth, should be dug and left open to atmospheric influences as long as possible before the tree is planted. The soil may also be sweetened and freed as far as possible from insect and fungoid pests by a dressing of quicklime. If fresh soil can be obtained to substitute for that dug out, the newly planted tree will have a better opportunity to flourish. Should the orchard happen to be on grass land, it will be an aid to the tree, also, if the grass be not allowed within 3 or 4 feet of it for the first few years after planting.

4, Whitehall Place, London, S.W.,
November, 1901.

Re-written, January, 1910.

A pamphlet containing 22 Leaflets dealing with Insect and other Pests injurious to Fruit Trees and Bushes may be obtained from the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W., price 1d. post free.

Copies of this Leaflet may be obtained free of charge from the same address.

BOARD OF AGRICULTURE AND FISHERIES.

The Colorado Beetle.

(*Leptinotarsa* (*Doryphora*) *decemlineata*, Say.)

This beetle, a member of the family *Chrysomelidae*, was first known in the west of the United States, and has now spread over the United States and Canada. In its native home it was known to feed on wild plants of the natural order *Solanaceae*, the family to which the potato, tomato and tobacco belong. About 1850, having found its way to the cultivated plants of settlers in the west, it began to travel eastwards. By 1859 it had reached Nebraska, and by 1865 it had crossed the Mississippi. It had passed north into Ontario by 1870, and in 1874 it had reached the Atlantic. Later it obtained a partial footing in England and the Continent of Europe, but prompt preventive and remedial measures removed the danger.

Food Plants.

The principal food of this beetle is the cultivated potato and it derives its economic importance from its destructive effect on this crop. The tomato is also attacked, and other plants on which the beetle has been known to feed are the thorn-apple, henbane, tobacco, belladonna, petunia, various poppies, pigweed (*Amaranthus retroflexus*), hedge mustard (*Sisymbrium officinale*), oats, smart-weed (*Polygonum hydropiper*), red currant, various thistles, goosefoot (*Chenopodium hybridum*), thorough-wort (*Eupatorium perfoliatum*), and mullein.

Grasses and other weeds have been known to harbour the larvæ. In some allotments at Tilbury Docks, where an isolated colony of these beetles was found and destroyed in 1901, the larvæ were observed feeding on woody nightshade (*Solanum dulcamara*), cabbage and thistles, while the eggs were found in one case on the sow thistle (*Sonchus*).

Harm Done.

Both the adults and the larvæ are destructive. The adult beetles destroy young plants just coming through the soil, eating them it may be to the ground. Beetles and grubs defoliate older plants. Where potatoes are not altogether destroyed, tubers may be produced, but they are likely to be small and poor in quality.

Description of Insect.

Adult.—The adult beetle is about one-third of an inch in width, and a little under half an inch in length. In colour it is yellow, with five longitudinal black lines on each wing-cover; the head has a triangular black spot; and the thorax bears dark spots and a more or less irregular V-shaped mark in the middle.

Egg.—The eggs are elongate-oval in form and orange in colour. They resemble those of some of the Lady-birds (*Coccinellidae*), but are much larger than those of any of our native species.

Larvæ.—The young, soft-bodied larvæ are of a dull red or red-brown colour, and bear some resemblance to the larvæ of Lady-birds. As they grow they become paler in colour, varying from a dull brickdust-red to an almost orange hue, with the head, legs, and posterior part of the first segment black. They also bear two rows of black tubercle-like spots along each side, the upper row being the larger and composed of seven spots. As the larvæ mature the body becomes somewhat swollen and more or less arched, the apex terminating in a kind of sucker, the upper part of the two apical segments being black. The full-grown larvæ are rather more than half an inch long when extended.

Pupa.—The pupa is of the same red or orange-red colour as the larva and bears black marks.

Life History.

In the imago or beetle stage the insect hibernates in the soil at a depth varying from a few inches to two feet or more, though eight to ten inches is the normal. They may also pass the winter among rubbish.

Genial weather in spring brings the beetles from their winter quarters. The beetles fly well and readily, especially during the warmer parts of the day.

The females lay their eggs in clusters of 9 to 40 or more on the under surface of the leaves, attaching them by one end. The eggs may hatch in less than a week, but, if conditions are unfavourable, hatching may be delayed beyond that period. Chittenden says that the larvæ take from 16 days to three weeks to attain maturity. When full-fed the larva leaves the plant and passes into the soil, where pupation takes place in a cell. The pupation stage in the most favourable conditions may be over in a week. Thus, where the environment is very favourable, the whole life cycle can be completed in a month. Two generations are recorded as occurring in some parts of the United States in the course of a year, and in other parts three generations. When the weather begins to turn cold in the autumn, the beetles bury themselves in the earth for hibernation.

COLORADO BEETLE (*Leptinotarsa* (*Doryphora*) *decemlineata*).
a. Eggs; *b*. Larvæ; *c*. Pupa; *d*. Beetles.

Natural Enemies.

A great number of natural enemies tend to check the Colorado beetle in America. Birds, especially the Rose-breasted Grosbeak (*Guiraca ludoviciana*), feed upon both larvæ and adults. Both ducks and chickens, but especially the former devour the larvæ.

In America the toad (*Bufo Americana*) gorges itself with the grubs, and our British species would probably also greedily devour them.

The insect enemies recorded by Riley are very numerous; they are chiefly predatory beetles and blood-sucking bugs or *Hemiptera-heteroptera*. Strange to say, no members of the *Hymenoptera*, the order that contains so many parasites, are actually parasitic on the Colorado beetle; a single species of wasp (*Polistes rubiginosus*), however, occasionally provisions its nest with the larvæ.

Theobald, when examining the allotments at Tilbury, noticed the large Seven-spotted Lady-bird (*Coccinella septempunctata*) in considerable numbers both in the adult and larval stages. The larvæ were seen in one instance devouring the eggs of the Colorado beetle, and, when placed in a box with some, ate them ravenously. Thus in the short space of time in which this potato pest existed in this country it found one natural enemy which, on account of its ravenous nature, would very materially check its increase. A single female Colorado beetle, however, is said to be capable of producing from 500 to 1,000 eggs.

Treatment.

In America an infestation is controlled by jarring the beetles off the plants into vessels containing paraffin. This method is very useful, as a large number of beetles are frequently to be found feeding together on the same plant. The pest is chiefly combated, however, by the use of arsenical sprays, arsenate of lead and Paris green both proving very effective.

The pest has appeared from time to time in Great Britain, but has always been exterminated. It was made the subject of legislation in 1877 by the Destructive Insects Act, and is included among the insects scheduled under the Destructive Insects and Pests Order of 1908. This Order requires the occupier of any premises on which the insect is discovered to notify the fact to the Board with particulars of the time and place of discovery, under a penalty not exceeding ten pounds. It also renders it illegal to sell or expose or offer for sale, without the written permission of the Board, any live specimen of the Colorado Beetle. Copies of the Order may be obtained on application.

4, Whitehall Place, London, S.W.
March, 1902.
Revised, February, 1910.

BOARD OF AGRICULTURE AND FISHERIES.

The Purchase of Artificial Manures.

In spite of their almost universal use, artificial manures are often so little understood that a few suggestions as to their purchase should be of interest and value.

Generally speaking, manures are applied to land to supply crops with what may be termed food materials. It is true that many organic manures, such as rape cake, dried blood, guano, &c., and, above all, such materials as farmyard manure, are extremely valuable in improving the physical character (texture, workability, water holding power, &c.) of soils, and cannot be valued merely as suppliers of plant food. It is, however, very seldom that purchased artificial manures are used in such quantities as to have an appreciable effect upon the physical character of the soil, and in ordinary cases their action in this direction may be regarded as too small to be valued separately, though it may be kept in mind.

Regarding artificial manures merely as supplying plant "food," it may be said that of all the materials taken by plants from the soil it is only necessary to apply three in the form of manure (a fourth substance, lime, is required by most soils, but not so much as a plant food as on account of its action on the soil. *See* Leaflet 170.) These three materials, usually referred to as nitrogen, phosphates, and potash, are therefore the only ingredients valued in artificial manures, and, other things being equal, the value of a manure is determined entirely by the amount of these substances which it contains.

Some manures contain only one of the three ingredients, *e.g.*, nitrate of soda, nitrate of lime, sulphate of ammonia and calcium cyanamide contain only nitrogen; superphosphate, precipitated phosphate, and basic slag contain only phosphates; and kainit, sulphate of potash, and muriate of potash contain only potash. Other manures hold two substances that are valued, as in the case of bones and fish meal, which furnish both nitrogen and phosphates, or saltpetre (very seldom used, however, as a manure), which supplies both nitrogen and potash. Excluding "mixed" or "compound" manures, only one class of so-called artificial manure, namely, Peruvian or other similar guano, contains an important amount of all three substances.

It has been stated above that only nitrogen, phosphates, and potash are valued in artificial manures, for they are the useful constituents on which the crop depends. For this reason, and in order that in other ways there shall be no ambiguity of expression, the Fertilisers and Feeding Stuffs Act, 1906, provides that *in an invoice the actual percentages of nitrogen, soluble phosphates, insoluble phosphates, and potash in any manure must be stated as such*, and not as ammonia, phosphoric acid, sulphate of potash, &c. Partly from custom, and partly for other reasons, the invoice is sometimes illegally made to show the amount of the last-named constituents present in the manure sold, and farmers and others in considering an invoice should be careful to notice whether the percentages of the manurial constituents relate to nitrogen or ammonia, phosphates or phosphoric acid, potash or sulphate of potash.

In trade circulars, price lists, and text books the use of the terms ammonia, phosphoric acid, sulphate of potash, &c., is still common, and it is therefore well to be familiar with the method of converting them to the legal terms. The common relationships are explained below under the headings *Nitrogen*, *Phosphates*, and *Potash*.

Nitrogen.

The relationship between nitrogen and ammonia need occasion no difficulty or uncertainty; 17 lb. of ammonia always contain 14 lb. of nitrogen, or, what is the same thing, 14 lb. of nitrogen are the equivalent of 17 lb. of ammonia. If, therefore, a sample of, say "Corn Manure," were said to contain 4·5 per cent. of ammonia, this would be the same as saying that it contained 3·7 per cent. of nitrogen. The figure may be made to look still more attractive by being stated as sulphate of ammonia, but this also raises no difficulty, for 66 lb. of this substance contain 14 lb. of nitrogen or 17 lb. of ammonia. The figures therefore mean one and the same thing, whether they are stated as 3·7 per cent. of nitrogen, or 4·5 per cent. of ammonia, or 17·4 per cent. of sulphate of ammonia. Yet a manure merchant, who failed to effect many sales for a fertilizer, of ever so high-sounding a name, on a statement of 1 per cent. of nitrogen or 1·2 per cent. of ammonia, might be more successful with a certain class of buyer if he entered the nitrogen as equal to 4·7 per cent. of sulphate of ammonia, though the three figures all represent the same fact.

Phosphates.

Phosphates in a manure may be in either an insoluble or a soluble condition and as the value in the two cases is widely different, the two forms must be separately mentioned in an analysis of manure. It is usual to give the percentage

of "phosphate of lime" soluble or insoluble as the case may be. Occasionally, but not often, the percentage of "phosphoric acid" only is quoted. This should cause no difficulty to the purchaser if it is remembered that 142 lb. of phosphoric acid always form 310 lb. of phosphate of lime. If therefore in a manure the percentage of phosphoric acid is quoted, multiplying by 2·2 gives the percentage of phosphate of lime to which this is equal.

Thus if the analysis of a manure shows it to contain 12 per cent. of phosphoric acid, it is equivalent to saying that it contains 26·4 per cent. of phosphates. Similarly 30 per cent. of phosphates is equal to nearly 14 per cent. of phosphoric acid.

Potash.

Potash usually exists in manure in the two forms of sulphate of potash and muriate or chloride of potash. It takes 94·2 lb. of pure potash to form 174·2 lb. of pure sulphate of potash, whereas the same amount of potash will form only 149·2 lb. of the pure muriate or chloride of potash.

Occasionally, instead of giving the amount of potash, an analysis shows the percentage of sulphate of potash. To obtain from this the percentage of potash divide by 1·85. Thus if a sample of kainit is said to contain 23·1 per cent. of sulphate of potash this means that it contains 12·5 per cent. of potash.

Just as a buyer may sometimes be led into purchasing a manure through its nitrogen being illegally expressed as sulphate of ammonia, so may the contents of potash be made to look more attractive by being stated as sulphate of potash.

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*The rules for approximately converting the various terms into their equivalents may be summarised thus :—

To convert	ammonia	into terms of	nitrogen	divide	by 1·2
" "	sulphate of ammonia	" " "	nitrogen	"	" 4·7
" "	phosphate of lime	" " "	phosphoric acid	"	" 2·2
" "	sulphate of potash	" " "	potash	"	" 1·85
" "	muriate of potash	" " "	potash	"	" 1·58

The Comparative Value of Nitrogen, Phosphates and Potash in different forms.

As explained above, the first thing that determines the value of an artificial manure is the percentage of the different manurial ingredients which it contains, but it

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* While this and the foregoing is given for the information of farmers and others it must again be emphasised that under the provisions of the Fertilisers and Feeding Stuffs Act, 1906, the analysis which must be given in an invoice shall state the percentages of nitrogen, soluble phosphates, insoluble phosphates and potash as such, and not as ammonia, sulphate of ammonia, &c. Any case where such percentages are not clearly stated should be reported at once to the Board.

must be remembered that nitrogen, phosphates, and potash may each exist in different forms which vary a good deal in efficiency and rapidity of action and consequently in value. Thus, it is quite possible for a manure to contain fairly high percentages of the three substances and yet be worth very little, owing to the extreme slowness with which the ingredients will become available for the use of the plant.

Nitrogen is mainly taken up by plants in the form of nitrate, so that nitrate of soda and nitrate of lime can be used by crops at once, and, on account of the rapidity and certainty of action, these forms, if properly used, generally give the greatest return in weight of crop for a given quantity of nitrogen supplied. In the case of other manures the nitrogen is not as a rule taken up directly but is first changed by the action of bacteria in the soil to the nitrate condition. This makes them slower in action than the nitrates of soda or lime, and while in many circumstances this is an advantage there is always a certain amount of loss in the process of change to nitrates. Roughly speaking it may be said that the amount of this loss varies according to the amount of change necessary, and the slowness of action of the manure. If properly used, more of the nitrogen is recovered in the crop when a quickly acting manure is applied than when a slowly acting one is used. It need hardly be said that the amount of change necessary and the rapidity of action vary greatly according to the manure, *e.g.*, sulphate of ammonia and calcium cyanamide change fairly quickly and are only slightly less rapid in their action than nitrate of soda, while such manures as dried blood, rape cake, guano, &c., are also fairly quick in action. In the case of shoddy or even coarsely ground raw bones, however, much of the nitrogen may remain unchanged and be quite useless as far as crops are concerned for years after the manure has been applied to the soil.

Phosphates, as already seen, can be divided into two classes—soluble and insoluble.* The different forms of soluble phosphates are the same in character, action and value, but there is considerable variation in the value of the different forms of insoluble phosphates. These are all insoluble in pure water, but are to varying extents dissolved by the slightly acid excretions of plant roots, and in order roughly to compare their value the method generally adopted is to find what proportion is soluble in a weak solution of

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* NOTE.—The terms soluble and insoluble as used in this leaflet mean soluble and insoluble in pure water. The Fertilisers and Feeding Stuffs Act, 1906, and the Regulations made under it, admit the use of the terms "insoluble phosphates" and "soluble phosphates" in relation to phosphates treated with a 2 per cent. solution of citric acid. But the fact that a solution of citric acid has been employed in making the analysis must be stated in the invoice. If nothing is said, "soluble" and "insoluble" always mean soluble or insoluble in pure water.

citric acid in a given time. This citric acid soluble phosphate must not be confused with the water soluble phosphate of superphosphate or dissolved bones. The main difference between the two is the rapidity of action of the latter due to its being more quickly distributed through the soil. After it has been in the soil a short time it "reverts" to a condition which, though not the same, is in effect similar to that of the citric acid soluble phosphate of "insoluble" manures.

It is probable that the phosphate insoluble in the standard solution of citric acid has no immediate fertilising value, and will become only very slowly available for the use of crops. Therefore, in valuing manures such as basic slag and compound manures, it is desirable to ascertain the proportion of the "insoluble" phosphate which is soluble in the citric acid solution.

To a great extent the value of phosphatic manures is determined by the fineness of grinding. Thus in a raw undegreased bone meal, which cannot be ground really finely, less than half of the phosphate may be soluble in the 2 per cent. solution of citric acid, while in steamed bone flour very finely ground the same phosphate may be soluble to the extent of three quarters or more in the 2 per cent. solution.

Apart from this, however, phosphates in different manures are of different nature and value. Thus, as a rule, about four-fifths of the phosphate in basic slag should be soluble in the citric acid solution, a higher proportion than in average bone manures, while that in mineral phosphate (the raw material from which superphosphate is made) is much less effective and less valuable for ordinary purposes.

Potash in all the commonly used manures—kainit, muriate and sulphate of potash—is soluble, and probably equally effective in the different forms. From time to time, however, there have been attempts to put on the market ground minerals and rocks containing potash in the form of double silicates—almost entirely insoluble and extremely slow in action. In these forms potash is certainly far less effective and less valuable than the potash in the soluble manures.

As some of the above statements are not in agreement with popular opinion as evidenced by the market prices of the various forms of manure, it is necessary to point out that in many cases too much attention is paid to prejudice and custom, and too little to the subject from a practical and commercial standpoint. Perhaps the most common tendency is to attach too high a value to slowly acting manures the maximum effect of which is not produced for, it may be, years after application. No doubt the use of such is often desirable to assist in improving the "condition" of land—though generally speaking the best plan of doing this is by such systems of manuring as dunging, feeding crops off with sheep and ploughing in of green crops—but when they are

used, it should be remembered that the slowness of action actually detracts from their intrinsic value instead of adding to it. This is apart from risk of loss and possibility of such occurrences as expiration of tenancy or changes in the system of farming. Just as £100 due in six years, or even six months, is not worth £100 to-day, so 100 lb. of nitrogen or phosphate which will not become effective till the more or less remote future is less valuable than the same quantity which can be brought into action this season.

It is also a radical mistake to suppose that the risk of loss of nitrogen (there is little fear of loss of phosphates or potash no matter in what form applied) is necessarily greater in a quickly acting manure than in a slowly acting one. Of course this may be so if the former is supplied to unsuitable crops or at the wrong time of year, but a farmer who understands their action is able to obtain an almost maximum return from them. The slowly acting manures are safer for a non-practical man, but no matter how they are used, a considerable proportion of the nitrogen will be lost.

"Condition" of Manures.

Too much importance cannot be attached to the necessity of having manures evenly distributed through the soil to which they are applied. Unless the manure is in a fine powdery condition it is almost impossible to secure this. Even in the case of a readily soluble manure which disappears into the soil almost as soon as it is applied, there is very little spreading *sideways* of solutions in the soil—practically all natural motion in a soil is up and down. The importance of this may be judged by the following illustration. If a manure is being applied at the rate of 5 cwt. per acre, 1 square foot receives only one-fifth of an ounce. With many manures this would be represented by a very small lump, which at most would not manure more than 1 square inch, or less than one hundredth of the area for which it is intended. Even after allowing for the slight mixing with the soil brought about by splitting drills or by harrowing, it is clear that if there is even a fair proportion of lumps—which are very often rather large—only a fraction of the ground is being manured at the rate intended, to say nothing of the actual poisoning of the spots on which the lumps fall.

Other things being equal, preference should certainly be given to a manure in a finely divided condition, and a little trouble and expense in keeping it fine and dry, and in applying it evenly, will be well repaid.

The Chief Artificial Manures.

The purely Nitrogenous Manures.—The most important of the nitrogenous manures are nitrate of soda and sulphate

of ammonia, others in less general use being nitrate of lime, calcium cyanamide, rape dust, blood meal, and shoddy.

Nitrate of soda and sulphate of ammonia are apt to be lumpy, and the farmer should therefore attend carefully to the mechanical condition. Nothing should be applied that will not pass a $\frac{1}{4}$-inch riddle. Lumps larger than this will often kill plants with which they may come into contact. (*See* also Leaflet No. 80, p. 10.) Nitrate of lime has great power of absorbing moisture from the air, and much loss may occur in storing for any period over a month unless care be taken to keep it properly protected from the atmosphere—as in air-tight casks. Calcium cyanamide, on the other hand, can be stored for a reasonable time under ordinary conditions without danger or sensible loss of its fertilizing properties.

Nitrate of soda is generally offered on the basis of 95 per cent. of purity (= 15·6 per cent. of nitrogen), while commercial sulphate of ammonia usually contains 97 per cent. of the pure article (= 20·6 per cent. of nitrogen). Nitrate of lime should contain about 13 per cent. of nitrogen; while calcium cyanamide contains from 15 to 20·3 per cent. of nitrogen, and 18 per cent. is usually guaranteed. Sulphate of ammonia is thus usually the most highly concentrated of the four manures.

The purely Phosphatic Manures.—Of the purely phosphatic manures, superphosphate and basic slag are the most important.

Basic slag generally leaves little to be desired as regards mechanical condition, provided the grinding be fine enough (80 per cent. through a No. 100 sieve—that is, 100 wires per linear inch, or 10,000 apertures per square inch—should be the minimum requirement). Superphosphate is sometimes almost as dry and mealy as slag, but in other cases it is lumpy and sticky. Samples of the latter character should be avoided.

Superphosphate contains from 25 to 38 per cent. of soluble phosphate, from 28 to 30 per cent. being a very usual quantity. Basic slag also varies in quality, the usual contents being 35 to 40 per cent. of insoluble phosphate, though there may be as little as 22 per cent., or as much as 45 per cent. Basic slag of inferior quality is often met with.

Steamed bone flour, though it usually contains a little over 1 per cent. of nitrogen, is regarded as practically a purely phosphatic manure. It generally contains from about 60 to 70 per cent. of phosphate of lime, and should be in an extremely fine dry condition, which makes it valuable for including in mixtures which would otherwise tend to "set" or become pasty. Of late years it has been almost the only form of bones cheap enough for use in ordinary

farm practice. It is more rapid in its action than raw bone meal, and though the nitrogen originally in the bones is removed with the gelatine, &c., in the steaming process, this is an advantage rather than otherwise, as the nitrogen can be more cheaply supplied from other sources, while the process makes fine grinding possible. "Boiled" bones have not been so thoroughly treated as steamed bones, and contain a little more nitrogen.

The Nitrogenous-Phosphatic Manures.—The most important of this class of manures are bone meal, dissolved bones, fish meal, guano, &c.

Bone meal should be very fine and free from grease. Any particles $\frac{1}{10}$ of an inch or upwards in size become available very slowly. It should contain about 50 per cent. of phosphates, and 4 or 5 per cent. of nitrogen.

Dissolved bones lose in value through being damp and lumpy; they can, however, be bought as dry and almost as fine as superphosphate. They usually contain 32–34 per cent. of total phosphates (of which more than half should be soluble) and fully 3 per cent. of nitrogen.

In recent years this class of manure has generally been too expensive for use except in limited quantities for special cases, though occasionally samples at fairly reasonable rates come on the market.

Potash Manures.—Genuine kainit contains about $12\frac{1}{2}$ per cent. of potash, and in addition over 30 per cent. of common salt. Where, therefore, a farmer needs to use the latter substance, in addition to potash, he may find it to his advantage to employ kainit.

Sulphate of potash is offered in various degrees of purity, containing from 25 to over 50 per cent. of potash. Muriate or chloride of potash often contains over 50 per cent. of potash.

Potash manures are apt to be lumpy, and if they are stored long they may become so hard as to be almost unmanageable. Poor mechanical condition is here quite as undesirable as in the case of other manures.

Valuation of Manures.

The necessity of having some means of valuing artificial manures is obvious. The market prices of manures are not fixed entirely by their intrinsic or real value, but fluctuate in accordance with ordinary laws of supply and demand. Thus in the last two years the price of sulphate of ammonia has risen to the extent of over £2 a ton, while that of nitrate of soda remained fairly constant until quite recently. As both manures supply the same material, nitrogen, in a condition very similar from the point of view of the plant, it is clear without any calculation that sulphate of ammonia was either cheap two years ago or was comparatively dear in the spring of 1912. Again, some manures, either on account of

their particular suitability for some special crop or for other reasons, are higher in price than is justified by their real value for ordinary purposes. It is possible, therefore, for anyone possessing the slight knowledge required, to save money by selecting the most economical forms of manure, and, furthermore, to protect himself against fraud in buying mixed or special manures.

It has been explained that, other things being equal, the value of an artificial manure is fixed by the amount of nitrogen, soluble phosphates, insoluble phosphates, and potash it contains. These amounts are always stated as numbers per cent., and as prices are, in farm practice, always quoted per ton, a simple system of valuation is possible.

Taking first manures supplying only one of the four ingredients mentioned :—

A farmer may ascertain, by obtaining quotations, that he can have nitrate of soda containing 15½ per cent. of nitrogen delivered at his station for £11 12*s.* 6*d.* per ton. In this case the cost to him of *one* per cent. of nitrogen is £11 12*s.* 6*d.* divided by 15½, or 15*s.* Similarly he may find that sulphate of ammonia, containing 20 per cent. of nitrogen, will cost him £15 10*s.* per ton. Dividing the price by the number per cent. we obtain 15*s.* 6*d.*, which is the cost of one per cent. of nitrogen as supplied in sulphate of ammonia.

Thus, the same thing that he could obtain for 15*s.* in nitrate of soda would cost 15*s.* 6*d.* in sulphate of ammonia—at the prices taken, nitrate of soda would therefore be slightly the cheaper source of nitrogen.

In the same way, if he can buy nitrate of lime containing 13 per cent. of nitrogen at £10 a ton, and calcium cyanamide containing 18 per cent. of nitrogen at £11 10*s.* 0*d.* a ton, the price of one per cent. of nitrogen, or the price per unit, is 15*s.* 5*d.* in the former and 12*s.* 9*d.* in the latter.

If all the four forms are equally suitable for the purpose for which the manure is intended, then, clearly, calcium cyanamide would be the cheapest form of nitrogen, and sulphate of ammonia the dearest at the prices named. It should be noted, however, that these prices are merely taken for purpose of illustration, and will vary not only from year to year but in different districts.

Again, a farmer who knows the price he will have to pay for different grades of superphosphate can decide which is the better value, as, assuming they are in equally good condition, the one that gives the lowest price per one per cent. of soluble phosphate is the cheapest.

For instance, a sample "25 per cent. soluble" at £2 10*s.* 0*d.* a ton is dearer than one "35 per cent. soluble" at £3 5*s.* 0*d.*

a ton, as one per cent. of soluble phosphate in the former costs 2*s*., while in the latter one per cent. is obtained for 1*s*. 10*d*.

In just the same way we can compare different grades of basic slag, or compare the cost of insoluble phosphate in basic slag with that in, say, steamed bone flour—though in the latter case allowance must be made for the small amount of nitrogen present.

Potash presents no greater difficulty; kainit containing 12·5 per cent. of potash at £2 10*s*. 0*d*. a ton gives a unit price of £2 10*s*. 0*d*. ÷ 12·5 = 4*s*. Sulphate of potash 80 per cent. pure (*i.e.*, containing 43·2 per cent. of potash, *see* page 3) at £10 gives a unit price of £10 ÷ 43·2 = 4*s*. 7½*d*. Muriate of potash 80 per cent. pure (*i.e.*, containing 50·6 per cent. of potash, *see* page 3) at £9 15*s*. 0*d*. gives a unit price of £9 15*s*. 0*d*. ÷ 50·6 = 3*s*. 10*d*.

Clearly, at these prices muriate of potash is the cheapest of the three sources of potash, while sulphate of potash is much the dearest.

The system can, however, be used not only to compare the value of manures of the same kind, but to determine roughly whether a manure containing more than one of the four manurial ingredients is worth what is asked for it. If a farmer has worked out for his own use the prices of various manures, as suggested above, he should have a very good idea as to what nitrogen or phosphates or potash cost him at his station at any particular time. Thus, assuming that the prices and qualities taken above for purposes of illustration apply to some particular case, he knows that on the open market nitrogen does not cost him more than 15*s*. 6*d*. per one per cent., and he is justified in assuming that he ought not to pay more than 15*s*. 6*d*. for it in a manure for ordinary purposes. In the same way the maximum price he is justified in paying for soluble phosphate would be about 2*s*. per one per cent.; for insoluble phosphate, about 1*s*. 4*d*. (assuming that steamed bone flour, say, one per cent. nitrogen and 65 per cent. phosphate, costs £5 5*s*. 0*d*. a ton); and for potash 4*s*. 7½*d*.

If, then, he is offered a manure containing any or all of the four ingredients he can estimate what is its highest value to him; just as if he had a mixture of so many quarters each of wheat, barley, oats, and peas, he could find the value of the whole mixture if he knew the value per quarter of each of the four kinds of grain.

A few examples may be given by way of illustration :—

A sample of Peruvian guano containing 8·4 per cent. of

nitrogen, 28·7 per cent. phosphate of lime, and 2·85 per cent. of potash is offered—what is its value ?

		s.	d.		£	s.	d.
8·4 % of nitrogen	at ...	15	6	=	6	10	2
28·7 % of phosphate*	„ ...	1	4	=	1	18	4
2·85 % of potash	„ ...	4	7½	=	0	13	2
Total value of manure per ton				=	9	1	8

in addition to which an allowance for the cost which would be involved in mixing the materials if bought separately, should be made.

Again, a turnip manure containing 3 per cent. of nitrogen, 8 per cent. of soluble phosphate, 12 per cent. of insoluble phosphate and 4 per cent. of potash is offered :—

		s.	d.		£	s.	d.
3 % nitrogen	at	15	6	=	2	6	6
8 % soluble phosphate ...	„	2	0	=	0	16	0
12 % insoluble phosphate...	„	1	4	=	0	16	0
4 % potash...	„	4	7½	=	0	18	6
Total value of manure ...					£4	17	0

plus allowance for mixing.

In the same way manures of any kind can be roughly valued, and it should be clearly understood that the value obtained in this way is the maximum value. That is, it assumes that the nitrogen, phosphate and potash are in available forms, and that of the available forms the most expensive have been selected for illustration. For instance, if instead of taking the costs of nitrogen and potash from those in sulphate of ammonia and sulphate of potash, the price had been taken from nitrate of soda and muriate of potash the calculation of the value of the turnip manure mentioned above would show not £4 17*s.* 0*d.* but £4 12*s.* 4*d.* If, as is possible, some at least of the nitrogen or phosphate were in the form of shoddy, ground feathers or leather, the value would be still less.†

It is not desired to emphasize this part of the question too strongly, for, as already explained, the value of a manure also depends on such questions as special suitability for the soil, crop and general conditions for which it is intended, on the availability of the ingredients it contains, and on such points as condition and convenience for general use. While, however, these must all be taken into account, the arithmetical

* Unless specially stated to be soluble, phosphate of lime refers to insoluble phosphate.

† *See* warning A $\frac{194.}{\text{I.}}$

valuation is absolutely necessary as a safeguard. The action of a farmer buying manure without valuing it in the way recommended can only be compared to that of buying stacks of corn on the strength of a sample of the grain, without making any endeavour to ascertain how many quarters each stack contains.

4, Whitehall Place, London, S.W.,
April, 1902.

Revised, June, 1912.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 10 leaflets dealing with Manures and Feeding Stuffs may be obtained from the same address, Price 1d., or 9d. per dozen copies, post free.

BOARD OF AGRICULTURE AND FISHERIES.

Cultivation of Maize for Fodder.

This crop has now been grown on a small scale in certain parts of England for about 20 years, having been definitely introduced into Britain as a regular crop about the year 1886. Its usefulness in dry summers and the reports of the success of the crop in Canada and the United States, have been the means of securing for it a largely increased amount of attention in this country.

Maize, when grown for fodder, does not demand a better climate than many districts of England are able to offer, while as regards soil-requirements and expenses of cultivation it compares favourably with most of our fodder crops.

Situation and Soil.

Taking an average of seasons it is doubtful if the cultivation of maize is likely to prove of advantage north of the English Midlands. In the Southern and South Eastern Counties, however, where a low rainfall, and frequently recurring periods of drought, make the growth of roots rather uncertain, maize offers the opportunity of securing a large bulk of succulent material that may, to a considerable extent, replace the common fodder crops.

While this crop may be grown on a variety of soils (sand, clay, and fen-land) it is found to give its best return on a deep loam.

Tillage and Manuring.

The land should be ploughed early so as to secure a good tilth, and in spring the ground should be cleaned, and generally prepared as for roots.

Ten or twelve tons of farmyard manure, ploughed in in autumn or winter, supplemented, when the crop is above ground, by 1–2 cwt. of nitrate of soda, would be sufficient manuring. In the absence of farmyard manure artificials alone may be employed, the dressing per acre consisting of 1 cwt. sulphate of ammonia, 3 cwt. superphosphate, and, on light soil, 3 cwt. kainit, applied before sowing; a month later 1–2 cwt. nitrate of soda should be given as a top dressing.

Seed, Sowing and After-Cultivation.

Seed.—Certain varieties of maize are specially adapted for fodder purposes, and in purchasing seed maize attention should be paid to this point. It is found, however, that satisfactory results are obtained in this country from the use of the ordinary flat white maize sold for feeding purposes, provided care be taken to ascertain by experiment that its germinating capacity is satisfactory, say 90 per cent. or upwards. It is of the utmost importance that such a test should be carried out, as owing to heating much commercial maize is incapable of germination.

The best results, on the other hand, are undoubtedly obtained by the use of specially selected seed.

Sowing.—The seed may be sown from the middle of May till the middle of June, though, in the case of May sowings, the young plants run considerable risk of injury from late frosts.

The seed may be sown in a variety of ways, *e.g.*, by hand-dibbling, by means of a bean drill, &c., the best results being attained by placing the rows not closer than 16 inches, and by burying the seed to a depth of about $2\frac{1}{2}$ to 3 inches. A plan that is followed with success is to deposit the seed in the bottom of every second furrow, as is often done in the case of beans. It may be mentioned that in America it is the custom to make the distance between the rows greater than in this country, say $2\frac{1}{2}$ to 3 feet. The quantity of seed varies between $1\frac{1}{2}$ and $2\frac{1}{2}$ bushels per acre. Heavy rolling after sowing is recommended by several of the best growers.

Protection from Rooks.—Great trouble arises, in many cases, from the attack of rooks, which search for the sprouting grain with much persistency. It is frequently absolutely necessary that means be taken to keep these birds off, and this is best done by "stringing" the field before the sowers leave it. If this operation be delayed, and the rooks discover that maize is in the ground, it is extremely difficult subsequently to keep them off. Tarring the seed before sowing, as a method of prevention, is also practised with fair success.

Cultivation.—When the young plants appear above ground horse and hand hoeing must be attended to, as in the case of other drilled crops; but when once fairly established maize, being a rank-growing plant—reaching, as it does, a height of 5 to 8 feet—will largely suppress weeds.

Yield and Composition.

The yield of green fodder varies considerably according to locality, soil and season, but may be given as varying from 15 tons on poor soils or in a bad season, to 35 tons on

good soil in a good season. As an average 20 to 25 tons may be expected on good land. The great value of the crop is evident when it is remembered that 20 tons per acre of a good food stuff may be obtained in less than four months after sowing the seed, even in seasons when grass runs short. It is not too much to say that no other crop commonly cultivated gives so much fodder in so short a time.

The feeding value of maize depends very much on the season, but is always high. In many respects maize can be more nearly compared with grass than with any other British crop. It is characteristically deficient in protein and in mineral matter, and therefore a large crop does not exhaust the soil as much as might be supposed. The following table shows the average percentage composition of green maize (at Wye College) at the end of September and in early October, in good, bad and intermediate seasons respectively, with pasture grass for comparison :—

Year.	Dry Matter.	Ether Extract.*	"Protein" (Nitrogen × 6·25).	Nitrogen Free Extract.*	Fibre.	Ash.	Sugar.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Good Seasons.							
1901	21·9	0·85	1·9	13·6	4·25	1·3	—
1905	18·7	0·52	2·04	9·88	5·30	0·98	1·0
Bad Season.							
1903	13·35	0·16	1·81	6·70	3·83	0·79	1·5
Intermediate Seasons.							
1904	15·00	0·66	1·59	8·06	3·74	0·95	0·80
1906	15·09	0·22	1·58	8·39	3·93	0·97	—
Pasture grass...	23·3	0·9	4·0†	10·9	5·2	2·3	—

Utilization.

Soiling.—The crop may be utilized as green fodder at any time when well grown, but in a favourable season it grows so rapidly during July and August that to cut during these months would entail considerable loss. At the same time it is very useful for scattering on bare pastures in August and September, and is particularly relished by all kinds of farm stock, and is almost as valuable for pigs as for cattle. A plan occasionally adopted on light soils in East Kent is to run sheep on the growing crop, ploughing in the stalks remaining after the sheep have cleared all they will. If maize is not required as a green fodder in September, it may be made into hay or silage.

* The "ether extract" is often called "oil" and the "nitrogen free extract" called "soluble carbohydrates."

† 1·1 of this is non-protein. *Vide* "Warington, Chemistry of the Farm," p. 130

Ensilage.—In America the main value of the crop is due to the opportunity it provides, through the agency of ensilage, of securing a supply of nutritious succulent material for use in the winter and spring months. In this country also maize is invaluable for this purpose.

The quality of the silage that maize produces is excelled by that of no other crop. If maize be utilized in this way it should stand till it is as mature as it is likely to become in this country, though it must be got off the fields before the occurrence of autumn frosts, which fatally injure maize. Generally speaking the latter half of September is the best time to make maize silage, which may be produced in stacks, draw-heaps, silos, pits, &c. (For general information in regard to ensilage, see Leaflet No. 9.) The practice of several farmers is to utilize as much of the crop as possible in a green condition, and, about the middle of September, to make what remains into silage. From investigations carried out at Wye College* it appears that the changes which take place in making maize silage are very complex. Although there seems to be no reason why the silage should not be fed to stock soon after it is first made, it is probably more economical and certainly more usual to keep it until February or well into spring, when roots are running short. By that time the fermentative changes are complete, the composition being very constant and showing far less fluctuation than that of the original maize. The following table shows the average composition of maize silage (at Wye College), compared with mangolds :—

Year (date of filling Silo.)	Dry Matter.	Ether Extract.	"Protein" (Nitrogen × 6·25).	Nitrogen Free Extract.	Fibre.	Ash.	Sugar.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1902	12·10	0·16	1·33	5·08	4·66	0·98	Nil.
1903	12·20	0·10	1·35	5·67	4·13	0·95	"
1904	13·79	0·83	1·65	5·15	5·06	1·10	"
1905	13·56	0·56	1·63	5·38	5·06	0·93	"
1906	13·32	0·29	1·30	5·61	5·20	0·92	"
Average ...	12·99	0·39	1·45	5·38	4·82	0·98	"
Mangolds ...	12·5	0·1	1·1	9·6	0·8	0·9	7·5

Notwithstanding its inferiority to mangolds maize silage is quite a useful food, readily eaten by bullocks, and, with certain exceptions, by dairy stock, when they have become accustomed to it. With proper care, too, the milk is not tainted.

* *See* Maize as a Fodder and Silage Crop, *Journal of the Board of Agriculture*, April, 1907, p. 14.

During the process of ensilage, there is considerable loss of weight, and in the Wye College experiments referred to the loss in dry matter was not less than 29 per cent., and even rose to 47·6 per cent., the soluble carbohydrates suffering most and the fibre least. Experience shows that mature maize suffers less in the silo than immature, and that loss can be somewhat reduced by rigidly excluding air, and by selecting varieties of maize which can be relied upon to give large and more mature crops containing 20 per cent. of dry matter without an undue amount of fibre. Maize silage, however, is hardly likely to compete seriously with roots or mangolds.

A good sample of maize silage is of a greenish brown colour, and emits an aroma almost indistinguishable from that of strong tobacco.

General Summary.

Large crops of maize can be produced in many districts, especially in the southern counties, Herts and Essex, and in parts of Cheshire and Norfolk.

The composition somewhat resembles that of grass; it depends on the season, and is least satisfactory in cold, wet seasons when the crop is small, and most satisfactory in hot, dry ones when the crop is large.

All classes of stock take to maize, and it is well worth a trial where succulent fodder is wanted during September. It is especially valuable for dairy cows, encouraging a large flow of milk.

Maize can be converted in silage, which is quite a useful food, though inferior to roots and mangolds. In the process of manufacture the loss of dry matter has been found to vary between 30 and 40 per cent., the loss falling mainly on the soluble carbohydrates and least on the fibre. Except when mangolds are unusually costly, it hardly appears worth while growing maize solely for the production of silage.

4, Whitehall Place, London, S.W.

March, 1902.

Revised, August, 1908.

BOARD OF AGRICULTURE AND FISHERIES.

The Composition and Properties of Concentrated Feeding Stuffs.

In making purchases of cakes and other feeding-stuffs a farmer often experiences a difficulty in arriving at a conclusion as to what material to buy, or which particular brand of cake to select.

It is clear that cost per ton is by no means the only factor that should influence his choice, but he is frequently uncertain as to precisely what other considerations should be taken into account, and what degree of importance should be attached to them.

It is the object of this leaflet to furnish a guide to the farmer in the purchase of foodstuffs. Information as to the compounding of rations for farm stock is given in Leaflet No. 79.

The first essential for the intelligent purchase of foodstuffs is that the farmer shall have a clear understanding of the nature and composition of foods, what functions in the animal the different ingredients perform, and the requirements and limitations of different classes of live-stock. *With* this knowledge it is possible to ascertain precisely in what respects and to what extent home-grown foods are deficient, and to purchase only such foodstuffs as can supply the deficiency to the best advantage. *Without* this knowledge one may be misled into purchasing materials which, though excellent enough in all general respects, are unsuitable and wasteful for special purposes. It should be understood. for example, that if decorticated cotton cake or soy bean cake is suitable for a given purpose, certain other foods (*e.g.*, maize, locust beans) cannot alone supply the requirements efficiently; that a milking cow requires a ration of very different composition from that which is most suitable for a fattening bullock (*vide* Leaflet No. 79); and that the use of certain foodstuffs (*e.g.*, undecorticated cotton cake) is attended with an element of risk, especially in the case of young animals.

Armed with knowledge of this character, the farmer, in estimating the relative merits of the different feeding-stuffs to which his attention is directed, should first of all obtain representative samples and submit them to careful inspection, using a magnifying glass for the purpose if possible. He may thus be able to detect any gross adulteration (weed seeds, dirt, etc.), and satisfy himself as to the palatability, freshness, hardness (if a cake), and other outward characteristics of each material.

Assuming that the foods are practically of equal value in these respects, the next proceeding should be to consider their suitability for the class of stock for which they are intended. (Information on this subject will be found in Leaflet No. 79.)

By this preliminary process of selection the unsuitable foods will be eliminated, and it will remain to ascertain which of the suitable foods it is most satisfactory and economical to purchase. This will be determined as regards a given feeding-stuff :—

a. By its composition, digestibility, and "productive value."

b. By its content of manurial ingredients.

The general significance of these factors is obvious, but it is necessary to indicate how they are taken into account in comparing the values of foods.

General Composition of Foods.

The component parts of all foods, whether home-grown or purchased, may be classed as follows :—

Feeding Stuff

- **Water**
- **Dry Matter**
  - **Nitrogenous substances**
    - **Albuminoids (Proteins)**
    - **Amides**
  - **Non-nitrogenous substances**
    - **Fats and Oils**
    - **Soluble Carbohydrates**
    - **Crude Fibre**
    - **Mineral matter (Ash).**

Commencing from the top, it will be seen that feeding-stuffs are primarily made up of water and dry matter, and that the latter consists of nitrogenous and non-nitrogenous constituents, which, again, may be sub-divided—the nitrogenous into albuminoids and amides, the non-nitrogenous into fats, carbohydrates, fibre, and mineral matter.

Albuminoids.—The albuminoids (or proteins) form a large and complex class of compounds. They are the true flesh, lean meat or muscle formers, and are sometimes termed the "essential" or "indispensable" food ingredients, because without them life could not be maintained. They contain nitrogen to the extent of about 16 per cent., which, together with part of the carbon, hydrogen, and oxygen, is utilised for the construction and repair of animal tissue ; while the rest of their carbon and hydrogen, by combustion in the body, is utilised to maintain the heat of the animal and to supply energy or mechanical force. Beyond this, the albuminoids, if used in excessive quantity, may contribute

to the production of fat, or, at least, may protect the fat stored up in the tissues from consumption. Only a relatively small proportion of the excess can be used in this way, however, and the rest is merely burnt up, and has no more value than an equal amount of carbohydrates, which are much cheaper. Many farmers supply their animals with unnecessarily large quantities of albuminoids, and thereby not only make their feeding unduly expensive, but in some cases may seriously affect the general welfare of their stock.

There is not yet sufficient reliable evidence to permit a definite statement as to the relative feeding values of the albuminoids contained in different foodstuffs. There is some reason to believe, however, that marked differences may occur when individual foodstuffs are fed separately, but that these differences will tend to disappear when the foodstuffs, as commonly happens, are blended together in a mixed ration.

Of the foodstuffs commonly used in this country the richest in albuminoids are soy bean meals and cakes and decorticated cotton-seed meals and cakes, these containing usually upwards of 40 per cent. of albuminoids. Next in order of richness come soy beans (35–37 per cent.) and linseed cake and meal (28–32 per cent.), whilst beans, peas, dried grains, and malt dust all contain 20 per cent. or more.

Amides.—The amides, although containing nitrogen, are greatly inferior in feeding value to albuminoids. According to the evidence now available they seem to have little or no direct value for the production of lean flesh or fat in the case of horses and pigs. In the case of ruminant animals (cattle, sheep, goats), however, certain amides or mixtures of amides can, to some extent, perform this function of albuminoids. In no case, however, has it been found possible to replace the albuminoids of the food completely by amides.

In all animals amides act as heat-producers, and therefore in this respect serve the same purpose in the body as the carbohydrates. In heat-producing capacity, however, the amides, weight for weight, possess only about half the value of carbohydrates.

Amides occur chiefly in immature or watery foods, such as young grass and roots; they are present in trifling quantities only in cereal grains, oil cakes, and other concentrated feeding-stuffs, with the exception of malt culms and molasses, so that, in the present connection, they may be left out of consideration.

Soluble Carbohydrates.—The most important soluble carbohydrates are starch, sugar, and mucilage. Carbohydrates abound in all foods and comprise the bulk of the feeding material in cereal grains, locust beans, molasses, hay,

straw, and roots. In these foods they must be looked upon as the chief ingredients of value. In oil cakes, pulse grains, dried grains, and malt dust, on the other hand, the feeding value is derived to a large extent from albuminoids and fats. The chief function of the carbohydrates is to supply heat and mechanical energy, and when fed in large quantity they are also capable of producing animal fat. In this latter respect starch appears to be superior to sugar, especially in the case of ruminant animals.

Fat and Oil.—The fats and oils are essentially heat-producers, and, weight for weight, are nearly $2\frac{1}{2}$ times as valuable for this purpose as the carbohydrates. When sufficient heat-forming food has been consumed to maintain the temperature of the body, fats and oils may be converted into animal fat, and so increase the body-weight. Whether for the production of heat or fat, the fats and fatty oils are far superior to either albuminoids or carbohydrates, but their use is restricted to moderate quantities by practical considerations. Of the foods in common use linseed, soy beans, linseed cake, and decorticated cotton cake are the richest in fat, after which come dried grains, soy bean cake, undecorticated cotton cake, oats, and maize.

Crude Fibre.—"Crude Fibre" is that portion of the foodstuff which remains undissolved after boiling in weak acid and alkali. It represents those ingredients which are of a more or less woody character, and it is essentially an admixture of cellulose with highly indigestible substances (lignin, cutin). Its value for feeding purposes varies widely according to its mechanical character and the class of animal to which it is fed. All farm animals have considerable powers of digesting the soft fibre of green food, but only cattle and sheep can derive appreciable nourishment from the hard fibre of foods like straw. Horses occupy an intermediate position in this respect, whilst pigs can only deal effectively with the softest types of fibre.

A high proportion of crude fibre, unless it is normal to the food in question (*e.g.*, undecorticated cotton cake) should always be regarded with suspicion, since it usually indicates the presence of husks or other highly indigestible material.

In general, foods containing more than about 10 per cent. of crude fibre will require special care in their use, especially if the fibre is largely in the form of hairs or "woolly" material.

Mineral Matter.—Mineral matter, although performing an indispensable function in animal nutrition, may be neglected in arranging diets for mature animals, as it is usually present in sufficient quantity in all foods. This constituent of food is of more importance in arranging diets for young, growing animals. It is then especially

important that the ration shall supply suitable quantities of lime and phosphoric acid, since these ingredients enter so largely into the composition of the bones. The supply should be ample, but in the case of phosphoric acid not very excessive.

The mineral matter of foods should not include more than a very small proportion of sand, as this is indicative of dirt. It is impossible in practice to ensure that foods shall be absolutely free from contamination of this character, but there can rarely be any valid excuse for the presence of more than, say, one or two per cent. of sand in a food.

Digestibility of Foods.

It is usually not difficult to get an analysis of a food stating the proportions of albuminoids, oils and carbohydrates present. Such an analysis, however, gives no information as to the digestibility of each ingredient, and yet it is only the digestible portions that can be regarded strictly as food. Except in the case of albuminoids, this information cannot be obtained in the laboratory, but recourse must be had to actual trials with animals. For the purposes of the valuation of foods, however, it will be sufficiently precise to take the average digestibility as tabulated on p. 7. A table giving the percentages of digestible constituents in average samples of the commoner feeding-stuffs will be found in Leaflet No. 79, p. 2.

Productive Value of the Digestible Matter of Foods.

One further consideration requires to be taken into account before a reliable estimate of the value of the food to the animal can be secured. The materials digested by the animal from a foodstuff cannot be applied solely and entirely to productive purposes such as the production of milk, meat or work. Even the most easily digested foodstuff requires to be masticated and forced along the alimentary tract, and in other ways causes extra labour to the animal. The supply of the energy required for this labour is a first charge upon the nutrients digested from the food, and only the balance is available for the productive purposes of the feeding. The tougher and more indigestible the food is, the greater will be the amount of digestible material diverted to unproductive purposes, and the lower will be the direct value of the food to the animal. In other words, if foods of very different character (*e.g.*, maize and undecorticated cotton cake) are compared it is necessary to know not only the *amount* and *character* of the digestible matter in the food but also its "*availability*" to the animal. The chief determining factor is the proportion and character of the crude fibre in the food, and in the case of all foods that are not markedly rich in crude fibre, no serious error will be committed if the digestible nutrients are regarded as fully "available." In

the case of fibrous foods, however, the value of the digestible matter will be considerably overrated if the presence of an abundance of crude fibre is not taken into account (see later).

Manurial Ingredients in Foods.

All foods contain appreciable quantities of valuable manurial ingredients, notably nitrogen, phosphates and potash. These ingredients are voided to a considerable extent in the solid and liquid excrements of the animals which consume the food. In the case of full-grown fattening animals or working horses practically all the fertilizing ingredients are recovered in this way, but in the case of young animals and cows in milk the proportion recovered will be lower. The proportions of nitrogen, phosphates and potash present vary greatly in different foods, and the value of the manurial residues arising from the consumption of equal weights of the foods varies accordingly. This fact must be taken into account in comparing the cost of different foods, since the real cost of a foodstuff to the farmer is obviously the price less the manurial value.

The latter value can only be assessed roughly and is subject in practice to great variations. For comparative purposes, however, the values given in the Table on p. 7 may be used.

Comparative Values of Foods.

Attempts have frequently been made to devise a satisfactory system of direct valuation of feeding-stuffs on lines comparable with those followed in the valuation of manures (*see* Leaflet No. 72). "Unit" prices for albuminoids, fats and carbohydrates have been calculated from the market prices of different foodstuffs, and these have then been used for valuation purposes. The system proves far more unreliable in its application to feeding-stuffs, however, than in the case of manures, owing to the fact that, unlike the latter, the market prices of different foodstuffs are regulated with but little regard to their composition. For this and other reasons the direct method has been generally abandoned in favour of the comparative method in which the value of a foodstuff is estimated by comparison with the price at which another of similar character and known composition can be obtained.

Two such methods are explained below, the first of which can claim little scientific basis but is found to work fairly well in practice, and is commonly used, whilst the second method is more scientific but more complicated.

Digestibility (per cent.) and Manure Values (per ton) of the Commoner Feeding-Stuffs.

Feeding-Stuff	Digestibility per cent.*				Estimated Value of Manurial Residues arising from consumption of One Ton of Feeding-Stuff. (Hall & Voelcker.)†
	Albuminoids.	Fats.	Soluble Carbohydrates.	Crude Fibre.	£ s. d.
Decorticated Cotton Cake	86	94	67	28	2 16 5
Undecorticated Cotton Cake.	77	93	52	18	1 13 9
Linseed Cake	86	92	78	32	1 18 7
Linseed	91	86	55	60	1 10 6
Soy Bean Cake	90	88	95	50	2 13 6‡
Soy Beans	89	90	69	36	2 1 8‡
Cocoanut Cake	78	97	83	63	1 11 6
Beans	87	83	91	58	1 11 8
Peas	86	65	93	46	1 7 4
Locust Beans	68	53	95	58	0 12 2
Bran (Wheat)	79	71	71	26	1 8 11
Malt Culms	80	71	73	55	1 15 11
Brewers' Grains (Wet)...	73	86	62	40	0 6 0
Brewers' Grains (Dried)	71	88	60	48	1 4 3
Rice Meal	57	85	80	15	0 14 3
Wheat	84	64	92	50	0 14 10
Barley	70	89	92	48	0 13 9
Oats	76	80	76	28	0 15 5
Maize	72	89	95	58	0 13 0
Meadow Hay	57	51	64	59	0 16 4
Clover Hay	54	53	64	46	1 1 9
Oat Straw	33	36	46	54	0 7 7
Barley Straw	25	39	53	54	0 6 9
Bean Straw	49	57	68	43	0 16 1‡
Pea Straw	60	46	64	52	0 13 4‡
Potatoes	51	—	90	—	0 4 6‡
Mangolds...	70	—	95	37	0 3 1
Swedes	80	84	95	74	0 2 6
Turnips	73	—	92	51	0 2 4

* Digestion by ruminants, based upon summary by Kellner.

† In estimating these values the unit-value of nitrogen, phosphoric acid, and potash have been taken at 12*s.*, 3*s.*, and 4*s.* respectively, and it has been assumed that the combined excrements, when applied to the land, contain one-half of the nitrogen, three-quarters of the phosphoric acid, and the whole of the potash contained in the ton of food.

‡ Data for these foods are not included in Hall and Voelcker's table.

First Method.—For the purposes of the comparison it is assumed that digestible albuminoids and fats are worth $2\frac{1}{2}$ times as much as digestible carbohydrates. The percentages of digestible albuminoids and oil are therefore added together and their sum multiplied by $2\frac{1}{2}$. To the figure

thus obtained is added the percentage of digestible carbohydrates, and the total is referred to as the number of "food-units" in the material. The price of a food-unit in one particular foodstuff is then ascertained by dividing its price per ton by the number of food-units contained in it. This "unit-value" can then be used as a standard by which to gauge the value of other similar foodstuffs of known composition. The following examples will illustrate the method.

Example I.—Suppose that two linseed cakes are offered with the guaranteed compositions and at the prices stated—

	A	*B*
Albuminoids... ...	32 per cent.	28 per cent.
Oil	11 ,,	9 ,,
Sol. Carbohydrates ...	34 ,,	35 ,,
Price per ton... ...	£9	£8 10*s*.

The numbers of food-units in each cake will be as follows:—

Cake A $(32 + 11) \times 2\frac{1}{2} + 34 = 141\frac{1}{2}$, or say, 141
Cake B $(28 + 9) \times 2\frac{1}{2} + 35 = 127\frac{1}{2}$, ,, 127

In the case of Cake A, 141 units are obtainable at a cost of £9, and the cost per unit is therefore $\frac{£9}{141} = 1s.\ 3\frac{1}{4}d.$ Hence if Cake B is to be relatively equal to it in cost, the price per ton demanded must not exceed $127 \times 1s.\ 3\frac{1}{4}d.$, *i.e.*, £8 1*s*. 6*d*. The price actually charged is thus probably somewhat in excess of the value of the cake as compared with Cake A at £9 per ton.

In this example two foods composed of practically the same ingredients are compared, and the assumption has been made that they are therefore of equal digestibility. If the foods are of similar character, but composed of different ingredients (*e.g.*, a linseed cake and a soy bean cake), the procedure is precisely the same except that the percentages of *digestible* albuminoids, etc., must first be calculated in each case from the guaranteed percentages of total albuminoids, etc., and then the sum of the digestible food units calculated from them. The following example will illustrate this case.

Example II.—Suppose it is desired to compare the linseed Cake A (Example I.) with a decorticated cotton cake containing 40 per cent. of albuminoids, 9 per cent. of oil and 27 per cent. of carbohydrates at £8 15*s*. per ton.

Using the data given in the Table on p. 7 the percentages of digestible nutrients in these foods are obtained as follows :—

—	Linseed Cake.		Decorticated Cotton Cake.	
	Total.	Digestible.	Total.	Digestible.
	per cent.	per cent.	per cent.	per cent.
Albuminoids ...	$32 \times \frac{86}{100}$	$= 27\frac{1}{2}$	$40 \times \frac{86}{100}$	$= 34\frac{1}{2}$
Oil	$11 \times \frac{92}{100}$	$= 10$	$9 \times \frac{94}{100}$	$= 8\frac{1}{2}$
Carbohydrates ...	$34 \times \frac{78}{100}$	$= 26\frac{1}{2}$	$27 \times \frac{67}{100}$	$= 18$

Then the total numbers of *digestible* food-units in each case are :—

Linseed Cake ... $(27\frac{1}{2} + 10) \times 2\frac{1}{2} + 26\frac{1}{2} = 120$
Dec. Cotton Cake $(34\frac{1}{2} + 8\frac{1}{2}) \times 2\frac{1}{2} + 18 = 125$

The cost per digestible food-unit of the linseed cake is $\frac{£9}{120} = 1s.\ 6d.$ At this rate the decorticated cotton cake should be worth 125 × 1*s*. 6*d*., or £9 7*s*. 6*d*. per ton.

In this method of comparing the prices of feeding-stuffs it is assumed that the differences in manure-values will be sufficiently allowed for in the high value that is assigned to the albuminoids, since it is the nitrogen contained therein that mainly determines the differences in manure-value between different foods.

The method works fairly well in practice so long as only materials of similar character are compared, but is very unreliable if applied to foods of widely differing character.

Second Method.—In this method the manure-value per ton of the foodstuff (*see* Table, p. 7) is first deducted from the price, and the balance then regarded as the nett cost. The subsequent procedure is then similar to that used in the first method, except that only the percentage of digestible oil is multiplied by $2\frac{1}{2}$, the albuminoids in this case being ranked equal only to the carbohydrates. This is in accordance with the most recent determinations of the relative values of the nutrients *to the animal* for productive purposes. Other factors which tend to raise the *market* value of albuminoids beyond this level will be discussed later.

For the purposes of illustration the case of the linseed cake and decorticated cotton cake compared in Example II. above may be taken. In each case the nett cost per ton is

equal to the price per ton, *less* the manure value per ton; thus:—

Nett cost per ton.

Linseed Cake: £9 − £1 18*s.* 7*d.* = £7 1*s.* 5*d.*
Decort. Cotton Cake: £8 15*s.* − £2 16*s.* 5*d.* = £5 18*s.* 7*d.*

The number of food "units" in each case will be—

Linseed Cake: $(10 \times 2\frac{1}{2}) + 27\frac{1}{2} + 26\frac{1}{2} = 79.$
Decort. Cotton Cake: $(8\frac{1}{2} \times 2\frac{1}{2}) + 34\frac{1}{2} + 18 = 74.$

The cost per "unit" of the linseed cake will be $\frac{\text{£}7\ 1s.\ 5d.}{79} = 1s.\ 9\frac{1}{2}d.$ At this rate the nett cost of the cotton cake should not exceed 74 × 1*s.* 9½*d.*, or £6 12*s.* 7*d.* This will represent a market price of (£6 12*s.* 7*d.* + £2 16*s.* 5*d.*) or £9 9*s.* per ton.

This method of assessing the comparative values of foodstuffs can be used with slight modification for the comparison of foods of very different character. In this case the "food-unit" totals by themselves are not a true measure of the relative values of the foods to the animals, since they take no account of the fact that the matter digested from an easily digestible food is utilised in the animal much more efficiently and economically than the matter digested from a more indigestible food. This difference turns largely upon the amount and character of the crude fibre present in the different foodstuffs, and may be allowed for by deducting from the total of food-units (including in this case the digestible fibre) one unit for every 3 per cent. (or 2 per cent. in the case of hays and straws) of crude fibre (total) present in the food.

Thus, suppose it is desired to compare the decorticated cotton cake of Example II. with an undecorticated cotton cake containing 22 per cent. of albuminoids, 5¾ per cent. of oil, 34 per cent. of carbohydrates and 20 per cent. of crude fibre. This composition would correspond (Table, p. 7) to the following percentages of digestible nutrients:—Albuminoids 17, oil 5½, carbohydrates 17¾, and fibre 3¾.

Decorticated cotton cake of average quality will contain, say, 8 per cent. of crude fibre, and hence 2¼ per cent. of digestible fibre.

Then the total number of food-units in each case will be—

Decort. Cotton Cake: $(8\frac{1}{2} \times 2\frac{1}{2}) + 34\frac{1}{2} + 18 + 2\frac{1}{4} = 76.$
Undecort. Cotton Cake: $(5\frac{1}{2} \times 2\frac{1}{2}) + 17 + 17\frac{3}{4} + 3\frac{3}{4} = 52\frac{1}{4}.$

These totals must now be subjected to the deduction, referred to above, based upon the percentages of crude fibre in each food. The corrected totals then become:—

Decort. Cotton Cake: $76 - \frac{8}{3} = 73.$
Undecort. Cotton Cake: $52\frac{1}{4} - \frac{20}{3} = 45\frac{1}{2}.$

The nett cost per unit of the decorticated cotton cake is then $\frac{£5\ 18s.\ 7d.}{73}$ or 1*s*. 7½*d*. At this rate the nett cost per ton of the undecorticated cotton cake should not exceed 45½ × 1*s*. 7½*d*. or £3 13*s*. 11*d*. Adding to this the estimated manure value per ton of £1 13*s*. 9*d*. (Table, p. 7) we arrive at an estimate of £5 7*s*. 8*d*. per ton for the market value of this cake as compared with the decorticated cake at £8 15*s*. per ton.

The results arrived at by either of these methods require to be interpreted with caution, since the composition of a food is only one of several factors which determine what price the purchaser can afford to pay for it. Thus the one requirement which the farmer cannot, as a rule, entirely meet by means of home-grown foods is the all-important one for albuminoids. Carbohydrates abound in all common farm crops ; oils can be largely dispensed with if necessary ; but albuminoids can only be replaced to a very limited extent by these other ingredients. Hence the farmer enters the market with his freedom of choice considerably hampered, and, in order to obtain a sufficiency of albuminoids, may find it necessary to purchase the relatively more expensive foods. It will, indeed, rarely be economical to buy foods rich in carbohydrates and correspondingly poor in albuminoids (*e.g.*, maize) except as substitutes for home-grown grain for the purpose of blending with other foods rich in albuminoids.

Again, the farmer may be so convinced of the superior merits of some particular food, say linseed cake, as to be willing to pay more for it than its composition alone would warrant ; or, on the other hand, the demand for certain other foods may, owing to prejudice or other reasons, be so unsatisfactory, or the supply so excessive, as to cause the merchants to offer them at prices which are lower than their composition would seem to justify.

It is, therefore, desirable to select as a standard for purposes of comparison some foodstuff in common use the price of which is little subject to such abnormal influences, and is reasonably steady. In the examples given in the preceding pages linseed cake was used as the basis of comparison. The values arrived at for the other foods will err therefore, if at all, rather upon the high than upon the low side, since the general popularity of linseed cake always assures for it a relatively high price. At the present time Egyptian cotton cake usually serves as an excellent basis for the purposes of comparison.

The Chief Feeding Stuffs.

Linseed.—The chief sources of the supply of linseed are India, Russia, and America. Russian seed is smaller and also darker in colour than the Indian seed. Genuine well-cleaned linseed weighs not less than 52 lb. per bushel.

The use of linseed—as distinguished from linseed cake—among farmers is chiefly restricted to the feeding of calves. It is found that linseed meal or crushed linseed added to skim or separated milk is one of the safest and most economical substitutes for the abstracted milk-fat. Linseed approaches more nearly in composition to the solids of milk than any other food, and the oil which it contains, to the extent of 34 to 38 per cent., is easily digestible. There is, however, a risk in buying any grain or seed in the form of a meal, as it is difficult to detect impurities when the material is sold in this condition. Farmers purchasing any considerable quantity of linseed meal will be well advised to have samples analysed. One of the commonest adulterants of linseed meal is ground linseed cake. The latter does not contain more than one-sixth to one-third of the oil in pure linseed, and the relatively larger amount of fibre in it renders it unsuitable for giving to young calves as a substitute for milk fat. Again, the meal of almost any cereal grain can be mixed with linseed meal in fairly large proportions before the substitution is likely to be detected with the naked eye. The object of such admixture is at once apparent, for linseed cake and cereal meals cost, roughly, from £6 to £10 per ton, whereas the price of genuine linseed is frequently about £20 per ton. The risk would be obviated by purchasing whole linseed and having it ground at home, but the objection to this is the difficulty of grinding owing to the linseed clogging the grist-mill.

Cakes are the pressed residues obtained in the extraction of oils from various seeds and nuts, *e.g.*, linseed, cottonseed, rapeseed, cocoanuts, earth nuts, etc. Apart from mixtures of materials that are specially compressed into cakes and sold under the description of mixed or compound cakes or feeding cakes, only four distinct kinds of oil-cakes are commonly used in this country, viz., linseed cake, decorticated cotton cake, undecorticated cotton cake, and soya bean cake. To a limited extent cocoanut cake and rape cake are also used.

Regarded as a group of feeding-stuffs, cakes may be considered as highly concentrated albuminoid or flesh-forming foods. For this reason, when consumed with a diet of straw and roots, which are essentially carbohydrate or heat-producing foods, they supply the feeding material that is most deficient. Where the straw is replaced by hay the concentrated food need not be so highly albuminoid in character, and, in that case, cereal grains may sometimes be economically substituted, partially or entirely, for cake.

Next to albuminoids the most important ingredient in cake is oil, and the price of certain sorts of cake is often largely controlled by the percentage of oil present. That the fattening capabilities of a cake are to some extent due to the oil there can be no doubt, as experiments upon sheep in this country have clearly shown the superiority of cakes rich

in oil over others poor in this ingredient; but farmers should be careful that the extra percentage of oil in a cake is not purchased at too high a rate. It is well known that oil is not equally valuable from whatever source it is derived, and it is important that all the oil in a cake should be the natural product of the seed from which the cake takes its name. Thus in a linseed cake the whole of the oil present should be linseed oil.

Any substitution of mineral oils for vegetable oils must be regarded as a flagrant adulteration, since the latter have no appreciable feeding value.

Linseed and cotton cakes contain no starch or sugar, the carbohydrates being represented by mucilage and cellulose. The amount of these present in such cakes is of minor importance compared with the albuminoids and oil, because the heat-forming (carbohydrate) substance is supplied in large measure by the straw and other bulky material with which cakes are always fed. Mixed or compound cakes often contain starch and also some sugar, their ingredients comprising grain, maize, &c., and a certain amount of spice.

Cakes, if pure and well made and free from fibrous husk, are extremely digestible, often as much as 80 to 90 per cent. of the nutrient material in them being digested by cattle and sheep. The manurial residues of cakes made from oil seeds are of higher value than those of any other foods, although the residues of malt dust, dried grains, beans, and peas are not greatly inferior.

Linseed Cake.—This is the residue left after extracting the oil from linseed or flax-seed. The quality and character of the cake varies with the following conditions:—(1) The kind of linseed used; (2) The manner in which the seed has been screened and freed from its impurities; (3) The amount of pressure and the degree of heating that have been employed in the extraction of the oil and the compression of the residue into cake.

In recent years the introduction of heating processes, and, more especially, the employment of chemical agents for the purpose of extracting the oil, have resulted in placing upon the market cakes which are very hard in consistency, close in texture, and poor in oil. It will usually be found in the case of linseed cakes that as the percentage of oil increases that of albuminoids diminishes.

No oil-cake is more liable to impurity and adulteration than linseed cake, and hence in purchasing this cake, farmers should insist upon having the consignment invoiced to them as "Pure Linseed Cake," or simply as "Linseed Cake." They should not be content with such phraseology as "95 per cent. pure," "made from 95 per cent. linseed" or "made from seed pure as imported." When a cake is invoiced as "Linseed Cake," the vendor is bound under the Fertilisers

and Feeding Stuffs Act to supply cake made from linseed alone and without admixture of other seed or substance. The term "Oil Cake" is very misleading, and may apply to cakes made from a variety of materials.

The chief kinds of linseed cake are English or home-made cakes, American, and Russian or Baltic.

Home-made cakes are usually fairly soft, and of late years they have been much freer from impurities than formerly, especially when sold under the designation of "Pure Linseed Cake." In regard to quality they usually contain 9 to 12 per cent. oil, and may be looked upon as intermediate in richness between American and Russian.

American cakes are usually rather hard and poor in oil, but are correspondingly rich in albuminoids.

Russian cakes are darker in colour than American cakes. They are usually rich in oil but are sometimes rather impure.

Rough Tests of Linseed Cake.—A rough idea as to the purity and quality of a linseed cake may be obtained as follows :—

(1) By inspection with the aid of a pocket magnifying glass and a penknife one can detect the presence of substances other than linseed when these are of fair size. As a rule, however, they are so much broken up as to be difficult of identification. The smooth, shining, dark, generally more or less triangular-shaped seeds of *Polygonum* can often be seen. The round, dark-brown husks of rape seed are familiar. The seeds of corn cockle are dark brown and very rough on the surface. Corn spurrey is a black seed with an almost smooth surface and surrounded by a delicate disc. Pieces of straw can sometimes be detected, and also sacking from the bags in which the cakes are pressed.

(2) The presence of too much sand may be suspected if the cake feels gritty when small pieces are crushed between the teeth. The flavour should be pleasing and not pungent or bitter.

(3) A jelly may be made by mixing one part by weight of the cake with six parts of boiling water. The jelly should have a mild taste and should not be bitter or rancid. If the jelly be covered up and warmed gently for some time the presence of mustard may be detected by the smell. Cakes resulting from the chemical process of oil extraction will not always form such a jelly. They are usually very poor in oil.

Linseed cake, like the seed, is highly valued for young or weakly animals, and is commonly regarded as unsurpassable for fattening cattle.

Although some other foods, or mixtures of foods, may produce as large an increase in fattening cattle, none has the same capacity for imparting "finish" and "touch." The

best feeders, therefore, generally finish their cattle on a liberal allowance of linseed cake. Should the supply exceed about 4 lb. per head per day, however, the flesh and fat produced are liable to be soft and lacking in agreeable flavour. Similarly, if more than this amount be given to milch cows, the butter-fat tends to become unduly soft and to acquire a linseed-oil flavour.

Circumstances may arise in which it becomes desirable to use home-grown grain instead of purchasing linseed cake for the fattening of cattle or sheep. The following substances may be mixed in the proportions indicated and ground in an ordinary steel grist-mill :—

8	bushels	oats.
4	„	barley (or maize).
2	„	peas.
1	„	linseed.

If this mixture be given to stock with an equal weight of ground decorticated cotton cake the whole will approximate in composition to good linseed cake.

Cotton Cakes.—Cotton seed, as it is gathered from the plant, is covered by a dense mass of long white cotton fibres. Cotton is removed from the seed by the process of "ginning," and when this is done the cotton seed has either a smooth, dark-brown hull or husk as in Sea Island and Egyptian cotton, or is covered by a dense greenish fuzz as in American Uplands cotton, or by a close ashy fuzz or velvet as in most kinds of Indian cotton. In the process of extracting the oil the kernels may first be removed from the hulls, or the hulls may be ground in along with the kernels. If the hulls are separated from the kernels we get decorticated cotton cake ; if the hulls have not been removed we get undecorticated, rough, or "English" cotton cake. The latter cake is usually made from Egyptian or Indian seed, and the former from American seed.

Decorticated Cotton Cake.—This cake, when well made and in good mechanical condition, may be considered one of the most valuable foods at the farmer's disposal. Weight for weight, it contains a larger aggregate amount of valuable material than any other food, and, as a rule, can be obtained at a price which, in relation to its composition, is very moderate. Further, it yields richer manurial residues than any other food. At one time this cake contained as a rule 14 to 16 per cent. of oil, but the quantity of this ingredient has now dropped to about 8 or 10 per cent. Some degree of compensation for the comparative poverty in oil is the increased percentage of albuminoids, which range from about 40 to 50 per cent., but deficiency in oil is often associated with a cake that is hard and "knotty."

The average composition of decorticated cotton cake at the present time is about 40 per cent. albuminoids, 8 or 10 per cent. oil, and 20 per cent. carbohydrates. At ordinary rates this is one of the cheapest foods in the market, though it is not suitable for calves, lambs, or other young stock, unless given in small quantities, and in a finely ground condition. It is not suitable for pigs.

It is most economically employed for dairy stock or fattening cattle, and as a rule should be accompanied by about an equal weight of some starchy food like maize or barley. When fed in this way experiments have shown that this food may be usefully employed both for fat stock and dairy cows. Provided that it be not used too liberally, it is superior to linseed cake where first-rate samples of butter are required ; it renders the butter firm and easily manipulated, and imparts good keeping qualities, and a high melting point ; it is thus specially useful in hot weather. The very high quality of the manure made from this cake is a point that experienced farmers do not overlook. This cake is largely used in certain parts of the country, notably in Scotland ; whereas in others it is rarely seen.

The chief points to be observed in purchasing decorticated cotton cake are :—(1) To ensure that the cake is made wholly from decorticated seed ; (2) to see that it is in suitable condition, and free from mould. With regard to the first point, the seed may not have been efficiently hulled, or the hulls may have been removed, ground up, and subsequently added to the meal, and the whole pressed into cake. Any appreciable quantity of coarse husks in the cake can be readily detected with the naked eye, but when the husks are present in a thoroughly disintegrated condition, their detection is only possible by chemical and microscopical examination. Cakes of this description exhibit a low percentage of oil (5 or 6 per cent., instead of about 10 per cent.), and a high percentage of fibre (10 to 12 per cent., instead of about 7 per cent.). Such cakes are intermediate in value between decorticated and undecorticated cotton cakes, and it is doubtful if sellers are justified in applying the description "decorticated" to some of the cakes now sold under that name. In view of the uncertainty attaching to the meaning of the term "decorticated" in this connection, purchasers of decorticated cotton cake should insist on a written statement from the seller as to the amount of fibre it contains.

The hard button-like pieces sometimes found in decorticated cotton cake are extremely objectionable. To produce a softer cake some manufacturers have lately adopted the

plan of grinding up the cake and re-pressing it into shape, while in other cases it is put on the market in a ground condition, and is often known as "yellow meal." As impurities are not so easily detected in the meal as in the cake, it should be bought with greater caution. If the cake is only moderately hard, and can be passed conveniently through the breaker, it may be crushed and left exposed to the atmosphere for a few days, when it becomes softer and more suitable for stock. When exposed to the air in this way decorticated cotton cake becomes darker in colour, and it may also be noted that freshly-made cakes are much brighter than old cakes.

Undecorticated Cotton Cake.—Two classes of this cake are in common use, these being termed for convenience "Egyptian Cotton Cake" and "Bombay Cotton Cake." The chief difference between them lies in the greater proportion of woolly fibrous matter in the Bombay cakes. For this reason greater caution is necessary in using them than in the case of Egyptian cakes. Bombay cakes are, moreover, usually rather poorer in albuminoids and oil, while they contain more sand, and are frequently "preserved" with borax. The average composition of the Egyptian cake may be put at about 23 per cent. of albuminoids, 5 or 6 per cent. of oil, and 30 to 35 per cent. of carbohydrates. The amount of fibre present is an important point; this is usually about 20 per cent., and should not rise much above that figure.

The most common faults of this cake are (*a*) the presence of too much cotton fibre, due to imperfect ginning of the raw seed; (*b*) excessive amount and coarseness of husk. After the ginning process there still remains attached to the husk a fine downy layer of cotton fibre, and this is extremely difficult to remove. Thus there is always a possibility that the seed will not be efficiently freed from such cotton, which can be easily detected by the woolly appearance of the cake when broken across. Coarseness of husk, and husk in excessive amount, are also serious objections, and have frequently been the cause of fatalities amongst stock.

The husk present in this cake possesses an astringent property which checks any tendency towards "looseness," and for this reason the cake is useful when fed along with laxative food, such as fresh young grass in the spring, and the aftermath or foggage of hay fields. In many parts of the country undecorticated cotton cake is the feeding stuff most commonly used during the grazing season.

The comparatively low percentage of oil and albuminoids, and the high percentage of fibre, render undecorticated cotton cake much inferior to decorticated cotton cake as a feeding material. Many experiments have been conducted with the object of contrasting the two kinds of cotton cake

as foods for fattening cattle. The evidence thus furnished is entirely in favour of the decorticated cake, which, irrespective of its superior manurial value, was found to be worth £2 to £3 per ton more than the rough cake.

Undecorticated cotton cake is, nevertheless, a most valuable food, and is extensively used for milk cows and fattening beasts. It is not a suitable food for young animals.

*Soy Bean Cake.**—The soya, soy, or soja bean, has during the past year or two entered somewhat extensively into farm economy as a feeding stuff, large quantities being imported from Manchuria. According to a number of analyses, the beans contain some 35½ to 41 per cent. of albuminoids, 21½ to 27 per cent. of carbohydrates, and 15½ to 18 per cent. of oil. The oil is extracted by pressure, and the residue forms the cake or cake-meal used for cattle feeding. This cake usually contains 41 to 45 per cent. of albuminoids, 25 per cent. and upwards of carbohydrates, and 6 to 8 per cent. of oil. Some of the cake and cake-meal which is being sold has had the oil extracted from it by means of a solvent instead of by pressure. In such cases only 1½ to 2½ per cent. of oil remains, and the proportions of albuminoids and carbohydrates are correspondingly higher.

Soy bean cake may be regarded as a useful feeding stuff when given to stock in suitable quantities and in combination with other foods. It approaches decorticated cotton cake in composition, and should be fed in the same way as that cake with starchy foods, roots, hay, and straw. A further necessity for caution in its use arises from the alleged purgative tendency of the soy bean oil.

Rape Cake.—This cake is not now much used as a feeding stuff in this country, the objection to it being the frequent presence of mustard seed, and the disagreeable flavour that it imparts to milk. It is, however, a highly nutritious food rich in albuminoids, and, if care be bestowed in its purchase, it can be advantageously given to stock, especially sheep, as the experience of several successful farmers testifies.

Cocoanut Cake.—This cake represents the residue left after pressing out the oil from the fruit-kernel of the cocoanut palm. It is used far more extensively on the Continent than in Britain, and is by many highly esteemed for milking cows. When fresh it has a pleasant nutty aroma, but soon turns rancid or acid. It has a hardening tendency upon the milk-fat. It contains a considerable proportion of crude fibre (usually 12–14 per cent.), but this is fairly easily digested.

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* *See* also *Journal of the Board of Agriculture*, Dec. 1909, p. 735; Feb. 1910, p. 940; and other issues.

Compound or Mixed Cake.—The use of cake of this description is apparently on the increase, at least in certain districts. Frequently some material, like ground linseed or cotton cake, is taken as a basis, and the bulk is made up of ground cereal grains, such as maize, barley, &c. As a rule, the mixture is flavoured and sweetened by the addition of spice, such as ground fenugreek or aniseed. Locust bean meal is also a favourite ingredient of these cakes, and of the mixed meals sold for lamb food and similar purposes. The sweet taste and pleasant aroma which accompany compound feeding cakes, and the high degree of relish with which they are consumed by cattle, largely account for their popularity amongst farmers. Many experienced feeders use large quantities of such cakes with the best results, but they should be bought with even greater caution than is necessary in the case of pure cakes. They furnish an opportunity of getting rid of material (such as musty cake, warehouse sweepings, &c.) that cannot readily be sold in any other way, so that the buyer of compound cakes has a special inducement to deal with a firm of high reputation, and frequently to take the opinion of an experienced chemist.

Brewers' Grains (or Distillers' Grains).—This material is a bye-product of the brewing and distilling industries, and represents the residues of the grains (chiefly barley) which have been converted into malt and subjected to thorough extraction with water. Grains contain all the husk of the barley and also the bulk of the albuminoids, but the greater part of the starch has been removed.

On farms in the neighbourhood of the brewery the grains are used in the wet condition as removed from the "mash tun," but for purposes of transportation to greater distances they are dried by special machinery until the moisture-content has been reduced to 10–15 per cent., and are then sold as "dried grains."

Wet grains are used practically only for milking cows, and are believed to promote the flow of milk. The opinion is general, however, that the increased yield of milk is accompanied by a deterioration in the quality of the milk if more than very moderate amounts of wet grains be fed. These opinions have not yet been adequately tested by experiment, but they receive no support from the results thus far obtained. Wet grains rapidly ferment and become sour on keeping, and hence cannot be stocked in large quantities.

Dried grains have proved to be an excellent food alike for fattening cattle, milking cows, sheep and horses. They seem to have a special value for sheep, excellent results having been obtained with mixtures of dried grains and decorticated cotton cake.

Malt Dust (Malt Culms, Coombs, Combings, or Sprouts) consists of the sprouts rubbed off the dried germinated barley in its conversion to malt. It is a highly digestible

and palatable food, but an appreciable proportion of the material that is digested consists of amides, organic acids, and other ingredients of low nutritive value. These ingredients impart to the food a sharp, appetising flavour, however, and the condimental effect thus produced is highly valued, especially for milking cows. This food is not suitable, however, for cows when approaching the time of calving.

The Pulse Grains.—These include the various forms of beans and peas, all of which are rich in albuminoids. Apart from the soya bean they are poor in oil, ordinary beans and peas containing only about $1\frac{1}{2}$ per cent. They are quite different in composition from the cereal grains, being much richer in albuminoids and correspondingly poorer in carbohydrates. The great estimation in which beans and peas, in the form of meal, are held for dairy cows is due to their richness in albuminoids and the beneficial influence which they exercise upon the quality of butter. Where it is intended to fatten cattle without cake or dried grains, some addition of beans or peas to the concentrated food is considered desirable by many farmers. These foods swell up considerably when soaked in water, and hence must not be fed dry in large quantities.

The Cereal Grains.—These include wheat, barley, rye, oats, and maize, which may all be grouped together as essentially carbohydrate, or starchy, foods. They contain roughly 60 to 70 per cent. of carbohydrates, 10 to 12 per cent. of albuminoids, and 2 to 5 per cent. of oil or fat.

The only class of stock to which wheat is generally given is poultry, and for poultry feeding it is unexcelled by any single food except, perhaps, short white oats.

Barley usually commands a price in this country that precludes its being profitably used as a food for farm stock. Inferior samples, unfit for malting, may be used for the same purposes as maize.

Oats are the staple concentrated food of horses, but may be replaced to some extent by beans, maize, barley, or mixtures of these grains. A mixture of beans and maize in the proportion of about $2\frac{3}{4}$ of maize to one of beans, constitutes a food very similar in composition to oats, and may for general purposes be used as a partial substitute.

Maize is the most starchy food in the market, and is always most appropriately fed with a highly albuminoid food such as decorticated cotton cake. As a concentrated food for general feeding purposes a mixture of equal weights of these two foods can hardly be excelled. The very small quantity of lime, and the low percentage of albuminoids in maize, largely account for its unsuitability as a food for young growing animals. When fed alone it also gives very unsatisfactory results as a poultry food.

Milling Offals.—In the milling of wheat for the production of flour, a number of bye-products, commonly referred to as "offals," are obtained, and these materials furnish an important class of farm foods. They represent the outer layers (other than husk) of the wheat kernel and range in character from a coarse bran to materials rich in floury particles ("middlings"). There is considerable divergence in the grading of these offals in different parts of the country, but for general purposes they may be grouped into the three classes of bran, sharps (or shorts) and middlings, the last-named being the most like flour in character, whilst "sharps" are intermediate between this and bran.

These "offals" are extensively used upon the farm, the finer grades being mainly used for pigs, whilst bran is everywhere used for all classes of stock, exercising a mild laxative influence which considerably enhances its value.

Rice Meal.—The material sold under this description should be a rice bran, free from rice husk. The latter is met with in commerce under the name of "rice hulls" or "rice shudes," and so far from having any appreciable feeding value, has actually an irritating effect upon stock, owing to its richness in hard fibre (30 per cent.) and silica (18 per cent.). Its presence in rice meals, increasingly prevalent of late years, is therefore strongly to be deprecated. Genuine rice meal is a highly digestible food, rich in oil and starch. The oil, however, appears to be of low nutritive value compared with the oils of oil-cakes. Practical experience with rice meal shows it to be best suited for pigs. It is one of the commonest ingredients of compound cakes, owing to its cheapness and richness in oil.

Treacle, or Molasses.—This is a substance which can often be very profitably employed. When of good quality it contains about 50 to 60 per cent. of sugar, and consequently has considerable feeding value, whilst it is much relished by cattle. When mixed with water, and used at the rate of a pound per head per day to moisten chaff, treacle is a very useful addition to a diet, especially when roots are scarce.

Molasses is now largely employed as a cattle food when absorbed by dried peat (moss litter) or by the pith of the sugar-cane. In this form the food is more convenient to handle than when in a liquid state. Care should be exercised, however, to avoid purchasing the convenience too dearly, where the absorbent material is highly indigestible.

A section of the Revenue Act, 1903, provides that molasses imported into Great Britain and Ireland shall not be liable to duty if intended solely for the purpose of food for stock.

Cod-Liver Oil.—Although cod-liver oil has not yet taken a place amongst the staple foods of the farm, the attention of farmers may be drawn to the fact that several practical

experiments have been conducted, showing considerable success from the use of this substance as a food for calves. The function of the oil is to supply the place of cream when rearing calves on separated or skim milk. It is given to the calves after they are about six weeks old, and in quantities up to 2 ozs. per head per day. Calves reared on separated milk and cod-liver oil do not gain in weight so rapidly as those fed on whole milk; but they will, if proper care be exercised, remain perfectly healthy, and they are reared at less than half the cost. It is a great advantage to continue to give the oil for some time after the milk has been stopped. The beef from animals fed in the early stages of their existence on cod-liver oil is in no sense inferior in quality to that from animals reared on whole milk. (*Sea also* Leaflet No. 142, *Calf Rearing*).

NOTE.—In order to obtain an analysis of a feeding stuff which would serve as evidence under the Fertilisers and Feeding Stuffs Act, a sample should be taken as required by the Fertilisers and Feeding Stuffs Regulations (*See* Leaflet No. 18) and a portion should be sent as required to the County Analyst. Preliminary information as to procedure can be obtained, if necessary, by addressing an inquiry to the County Analyst, and the assistance of an Official Sampler can be requisitioned. The fees payable vary in different districts.

4, Whitehall Place, London, S.W.
September, 1902.
Re-written, March, 1911.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, *Whitehall Place, London, S.W.*

A pamphlet containing 10 *leaflets dealing with Manures and Feeding Stuffs may be obtained from the same address, price* 1*d. each, or* 9*d. per dozen copies, post free.*

BOARD OF AGRICULTURE AND FISHERIES.

Root-knot Disease in Cucumbers and Tomatoes.

Cucumbers and tomatoes are often affected by a disease induced by the Root-knot Eelworm (*Heterodera radicicola*, Greeff.).

The first symptom of attack is a drooping and yellowing of the foliage, followed by the stem becoming limp, and a collapse of the entire plant.

The finer branches of the root are more or less studded with swollen portions or "knots," varying in size up to one quarter of an inch across; knots of larger size are also often present on the thicker branches of the root (*see illustration on page* 2).

Microscopic examination shows the presence of numerous eelworms in the knots. In these knots the females lay their eggs.

The eggs hatch into tiny eelworms. The young eelworms leave the swellings or knots and pass into the soil to seek fresh plants or places for attack; they bore into the roots. The young worms are $\frac{1}{75}$th of an inch in length. As a result of the boring and the presence of the worms the galls or swellings or "knots" are produced. In the course of their development the eelworms gradually increase in diameter, the females becoming permanently rounded or pear-shaped. The males swell at first, but they regain and then retain their worm-like elongated form.

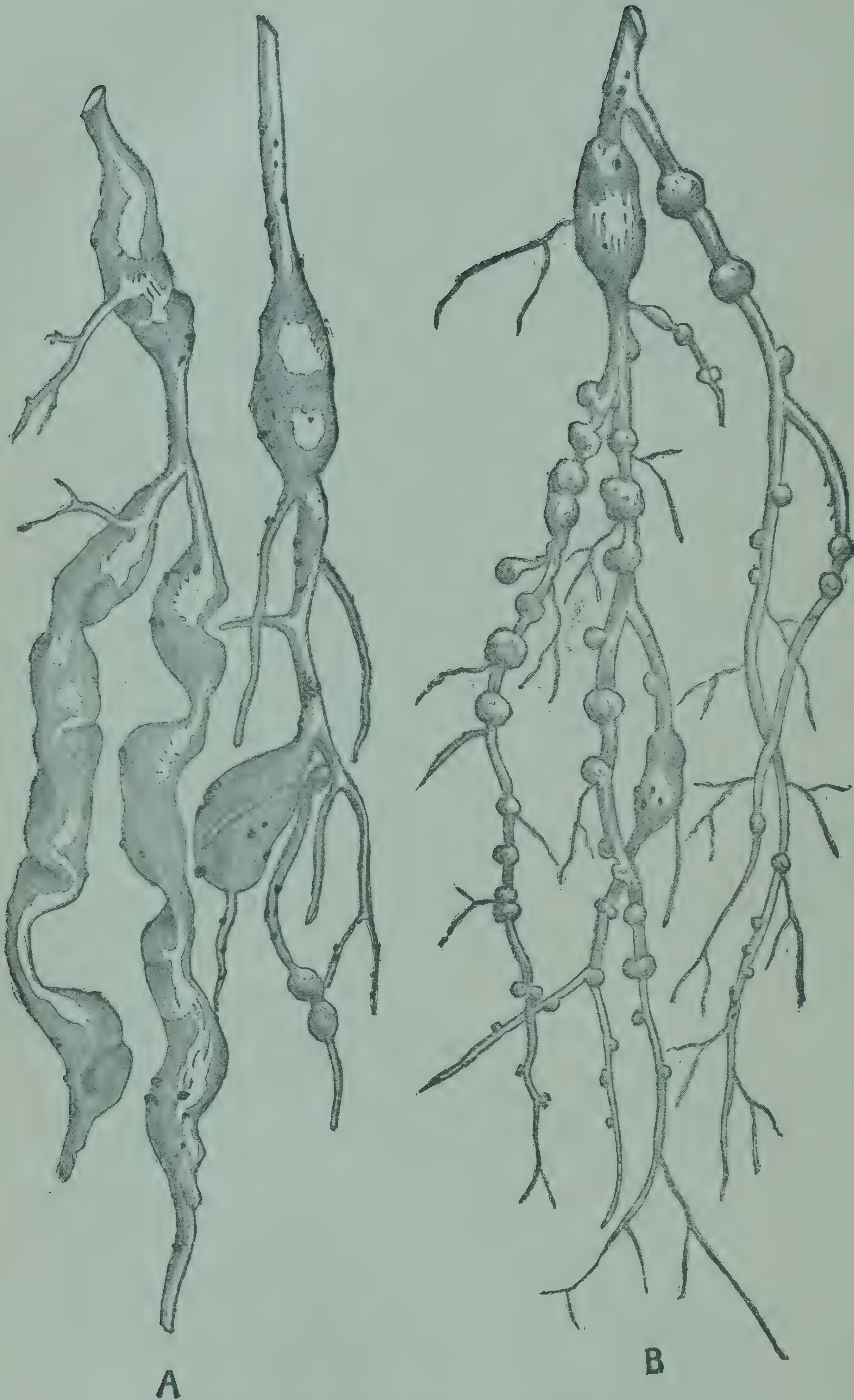
Prevention and Remedy.

1.—To destroy these eelworms the soil must be thoroughly saturated three times, at intervals of a fortnight, with a solution of one part of carbolic acid in twenty parts of water.

2.—A second remedy consists in mixing the soil intimately with gas-lime.

In either case the soil so treated must remain for at least six weeks before it can be used.

3.—When soil in a house is infested, it is safest to remove the whole and treat it outside; the interior of the house should then be thoroughly washed with a solution of one part of carbolic acid in eight parts of water.



Roots of (A) Cucumber, (B) Tomato, attacked by Root-knot Eelworm.

4.—Mixing naphthalene with infested soil has been recommended, and some fumigants which contain naphthalene as an important ingredient have been favourably reported on.

5.—Russell and Petherbridge found that *Heterodera radicicola* and other species of eelworms were killed by heating the soil to a temperature of 140° F. Sterilisation of the soil by exposure for about one hour to a temperature of 200° F. is, however, recommended. Infested soil may, therefore, be removed, partially sterilized and again used for growing cucumbers and tomatoes. Information as to experiments in the partial sterilisation of soil for glasshouse work is given in the *Journal of the Board of Agriculture*, January, 1912.

6.—A very important and somewhat discouraging fact to bear in mind is that a very large number of plants in addition to the cucumber, marrow and tomato, have been recorded as host plants for *Heterodera radicicola*. Among them are cultivated cruciferous plants, red and crimson clover, black medick, peas and beans, lettuce, potatoes, beet, some grasses, some rosaceous and other fruit plants, and such weeds as the dandelion and the rib-grasses or plantains. The practical import of this on the possibilities of spread of the pest is evident.

7.—In experiments conducted at Kew against another species of eelworm infesting clover it was found that the eelworms were destroyed by treating the diseased plants with sulphate of potash, the quantity used in the experiments being equal to 4 cwts. to the acre.

8.—The plants ruined by this eelworm should not be allowed to remain, or be just thrown on the manure heap, but should be burned.

4, Whitehall Place, London, S.W.,
November, 1902.
Revised, April, 1912.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 76.

BOARD OF AGRICULTURE AND FISHERIES.

Cucumber and Melon Leaf Blotch.

Cercospora Melonis, Cke.

This fungus, although first observed and described as a new species so recently as 1896, has spread with remarkable rapidity, and at the present moment is the most destructive parasite with which the cultivator of cucumbers and melons has to contend. In several instances growers report an annual loss of £2,000, whereas others have had to abandon the cultivation of these plants owing to the repeated destruction of their entire stock, in places where the fungus has secured a firm foothold.

The foliage is the part first attacked. At a later stage the fruit often also suffers. The first indication of the presence of the disease is the appearance of a few small, scattered, pale green spots on the upper surface of the leaf. The spots gradually increase in size and also in number, and often run together, gradually passing through grey to a brownish or ochreous colour. If at this stage the upper surface of a diseased spot be examined with a pocket-lens, it will be seen to be covered with delicate upright brown threads, each bearing a conidium at its tip. This represents the fruiting portion of the fungus, the mycelium or hyphae being buried in the substance of the leaf.

The minute conidia or reproductive bodies are carried from diseased to healthy leaves by currents of air, insects, clothing, &c., or by spraying, and if the leaf surface is moist such conidia germinate and the germ-tubes enter the tissues of the leaf directly.

Very frequently a leaf becomes quite dry and crumbles to the ground within twenty-four hours of the first infection. Such dead fallen leaves are much more responsible for the rapid spread of the epidemic than are the conidia which pass directly from one leaf to another.

When the dry fragments of a diseased leaf fall on damp earth, the mycelium present in the tissues quickly commences growth and forms an exceedingly delicate cobweb-like mycelium which runs on the surface of the soil and produces myriads of very minute conidia, which are dispersed

by currents of air, and infect the leaves in a manner similar to that of the larger conidia borne on the leaves.

The mycelium in the soil originating from diseased fallen leaves continues to extend and produce conidia so long as the requisite conditions as to moisture and temperature are present. When these conditions fail, the mycelium passes into a resting condition, but readily assumes renewed activity when stimulated by returning moisture and heat. By this means the fungus survives from one season to another in the soil, and the disease is almost certain to recur year after year in a house that is once infected, unless the soil is thoroughly sterilised.

It is important to remember that the disease under consideration can only assume the proportions of a destructive epidemic when attacking plants grown under glass, and where a high temperature and an excess of moisture are present. Such conditions, accompanied by a deficiency of light, result in the production of "soft" foliage, and it is only such soft foliage that the fungus can attack. Experiments carried out at Kew prove that the fungus cannot inoculate leaves that have developed under "lights," or in the open air. Plants that are badly diseased, if removed to the open air produce new foliage, which remains perfectly healthy.

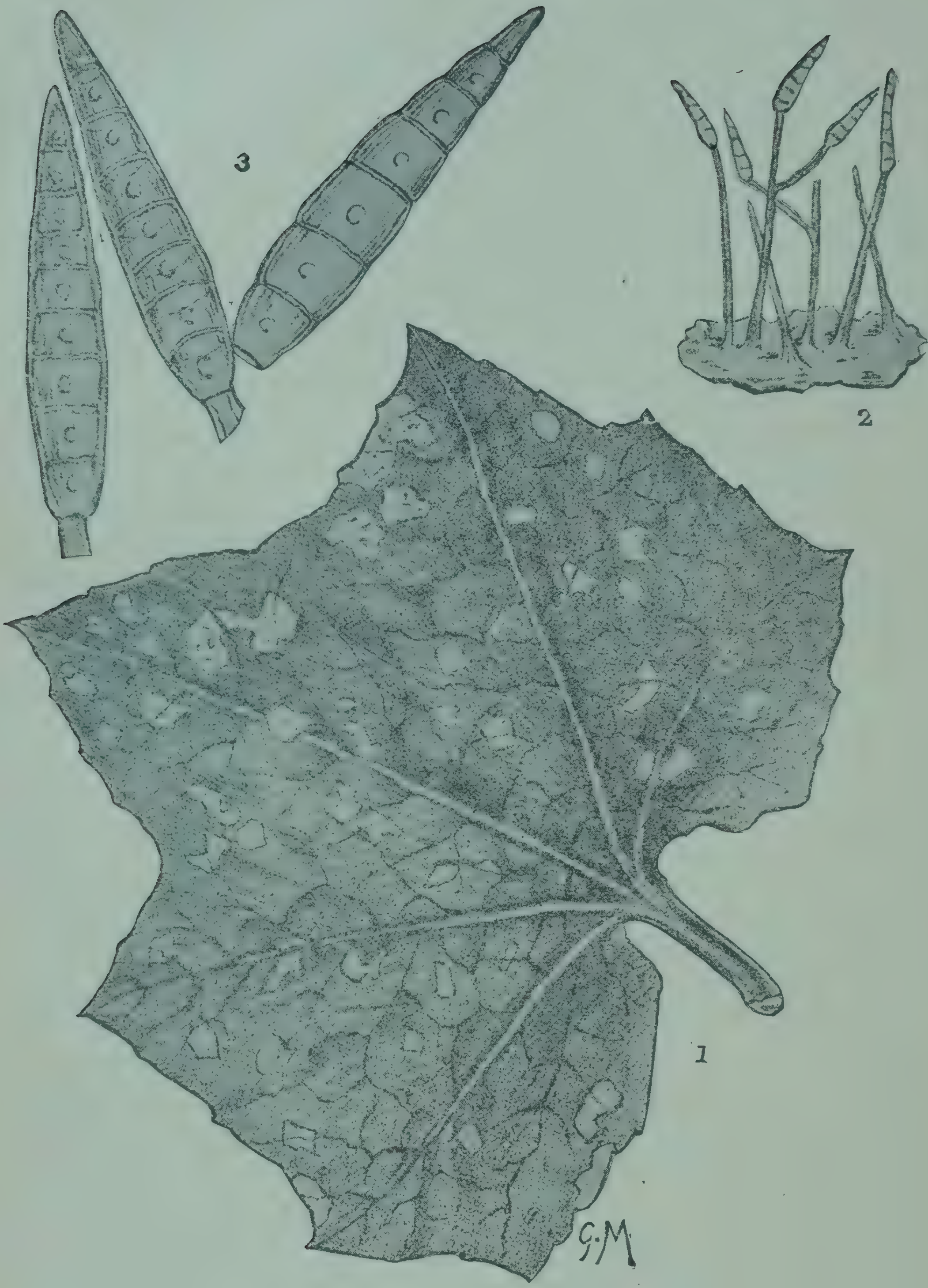
The disease is entirely an artificial creation, rendered possible by the rushing mode of cultivation followed.

The seed remains perfectly free from disease, hence there is no fear of its introduction from this source, and its sudden appearance in a new locality remained inexplicable until indicated by the following incident :—An establishment in Hertfordshire sending consignments of cucumbers to Covent Garden Market remained free from the disease until the commencement of the present season, when on one occasion some empty "flats" or packing boxes that had contained cucumbers, sent from a place where the disease was known to be rampant, were by mistake returned from Covent Garden to the Herts establishment, where from that date the disease appeared and is now practically beyond control.

To test the possibility of this means of introducing the disease, an empty box that had contained diseased cucumber leaves sent to Kew for determination, was placed over a young vegetable marrow plant that was growing under glass ; within three days every leaf was destroyed by the disease. Another marrow plant growing in the open and subjected to similar treatment did not contract the disease.

Preventive Measures.

If the foliage is fairly hard the disease cannot assume the dimensions of an epidemic, and even if it appears it can be



Description of the Figures.

1. Cucumber leaf shewing the disease in an early stage of development. Natural size.
2. Portion of a diseased patch of leaf shewing the fruiting condition of the fungus. Magn. 40.
3. Ripe Conidia. Magn. 400.

kept well in hand by spraying. To accomplish this end a fair supply of air should be admitted so that the atmosphere is not constantly saturated with moisture. It is wise to spray in anticipation of the disease, using a solution of potassium sulphide—two ounces to three gallons of water, adding two ounces of soft soap.

It is very important that the under surface of the leaves be thoroughly wetted with the solution.

If the disease is present, the soil should also be drenched with the solution.

Diseased leaves should be removed and burned before they decay and fall to the ground.

After a diseased crop has been removed the soil should be thoroughly drenched with a solution of "Jeyes' Fluid," in the proportion of an ounce to a gallon of rain water.

As to the danger of infection arising from spores being conveyed in packing cases as recorded above, no suggestions can be offered ; nevertheless the matter is one claiming the attention of cultivators, and as the wholesale mixing up of such hampers appears to be the rule rather than the exception, it is probable that many diseases other than the one under consideration have by this means been first introduced to a new locality.

4, Whitehall Place, London, S.W.
October, 1902.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 77.

BOARD OF AGRICULTURE AND FISHERIES.

Finger-and-Toe in Turnips.

(*Plasmodiophora brassicæ*, Woronin.)

This disease, known also as Anbury, Club Root, and "Grub,"* attacks most, if not all, crops belonging to the order Cruciferæ, such as turnips, swedes, cabbages, kohl-rabi, rape, and radishes, and often proves very destructive. The cause of the trouble is a fungus so small as to be perceptible only by the aid of a strong microscope. This minute organism is capable of existing for years in a quiescent condition in the soil, but when a crop that it can attack is sown upon the ground it enters the fine roots, multiplies rapidly in the tissues, and induces malformation and decay.

Like many other fungoid diseases finger-and-toe is extremely infectious, as may be readily proved by taking some portions of diseased root, or soil from a diseased field, and spreading such material on uninfected ground on which plants belonging to the cabbage and turnip order are to be grown. In the great majority of cases such treatment will be followed by an attack of the disease, which, however, in the first year, will be sharply confined to the area thus artificially infected. This shows that finger-and-toe does not spread from plant to plant through the air, as is the case with many other diseases such, for example, as potato disease. It does, however, readily spread from the first point of attack in various ways; for instance, it may be borne in soil which sticks to the plough, to the wheels of carts or other agricultural implements, or to the feet of workers, horses, or sheep. Should a small patch of turnips in a large field be affected by finger-and-toe, a certain amount of soil will be borne from this patch and dropped elsewhere on the field every time a plough, harrow, cultivator, or scuffler crosses it, and wherever such soil is dropped a new centre of infection is established. Or the crop may be consumed on the land by sheep, and the animals crossing and recrossing the diseased patch will soon bring about infection on a wider area. Under other circumstances the

* The term "Grub," which is a very common name in some districts, is one which should not be used for finger-and-toe, but for the swellings produced by the grubs of the turnip gall-weevil (*Ceutorhynchus sulcicollis*). This insect produces on turnips and allied plants swellings which are not unlike some of the growths caused by finger-and-toe; but there is no connection between finger-and-toe and the tiny grub found on cutting open the galls formed by the gall-weevil; the latter pest often does some injury to a turnip crop, but this injury is trifling compared with that which may be caused by finger-and-toe. Confusion between the fungus and the insect is responsible for some of the erroneous opinions which are expressed upon the subject of finger-and-toe.

crop may be lifted and carted to the homestead in which case it is in practice impossible to prevent some of the diseased turnips getting amongst the dung, which, if used to manure a turnip crop on another field, may cause the disease to appear where it was never seen before, or may reinfect a field previously cured. Or diseased roots may be spread on a grass field to be consumed by stock, and a year or two later this field may be under turnips, when serious infection may be revealed. The refuse of the root house is a fruitful source of infection, and such material should never be put either amongst the dung or on a tillage field.

Prevention and Cure.

Although this disease is widespread, destructive, and difficult to eradicate once it is firmly established, much may be done to limit its ravages. It is practically unknown on soils naturally containing a high percentage of lime. The artificial application of burned lime has long been practised as a preventive, and this substance is still the most effective agent known. The usual custom is to apply 3 to 7 tons per acre, the dressing being given in the autumn either six months or eighteen months before a turnip crop is to be grown. On the whole the better of these two systems would appear to be that of applying the lime eighteen months ahead of the turnip crop. Under either the four or five-course shift, this will mean spreading the lime on the ley before it is broken up for a corn crop.

Perhaps even a better plan is to put on a dressing directly after a turnip crop is removed. This allows more time for thorough distribution of the lime through the soil without which its full influence cannot be exerted, and although its effect on finger-and-toe is not seen for at least three years *i.e.*, till the next turnip crop comes to occupy the ground, it may be of material advantage to the intervening crops, particularly perhaps the clover. If a considerable amount of disease is present $2\frac{1}{2}$–3 tons of lime per acre may be applied, whereas if the field is sound, or nearly sound, the dressing need not exceed 1 to $1\frac{1}{2}$ tons. In this latter case the treatment is to be regarded purely as a preventive measure. To spread a small quantity of rough lime evenly over the land it is advisable first to slake it, and afterwards to employ a suitable manure distributor (see Leaflet No. 170) ; in the absence of a distributor it is a good plan to fill the slaked lime into carts, spreading by means of shovels directly from the carts.

One manifest advantage of applying lime immediately after a turnip crop has been grown is that one can readily see where the disease, if any, has been most destructive, and increase the dressing accordingly. The use of ground lime in small quantities (5 to 10 cwt. per acre) has been extensively tested, but the results do not show that lime in this form is more effective than slaked lime, if the latter

is carefully spread, while it is more costly, and often less pure. Moreover, such a small dressing has but little effect on the disease, though it may have a considerable influence in other ways.

Other forms of lime are more or less effective, though none is so powerful as common burned limestone, which is slaked before spreading. If gas lime be used it should not be put on later than 18 months before turnips are to be sown. Chalk has also a preventive influence, though its effects are weaker than those of burned lime, and from two to three times as much should be applied.

Specimen of Turnip (slightly reduced in size) in advanced stage of attack by Finger-and-Toe.*

Although the virulence of this disease can be minimized by the use of lime, there is no doubt that to get rid of it completely, careful attention must also be paid to other

* From a photograph lent by the Northumberland Education Committee.

measures. Attention has already been called to the extraordinarily infectious character of the disease, and this fact should always be borne in mind by those who have to deal with affected land. It often happens that, to begin with, the disease appears only in certain small portions of a field, frequently the headlands, and while it is still on a circumscribed area no trouble or expense should be spared to stamp it out. If this be neglected it will soon spread all over the field, and, with careless management, all over the farm. Working the land while out of condition is a fruitful predisposing cause of an outbreak. Land that is soured by want of drainage, or in consequence of a burst drain, frequently exhibits the disease.

Neglect in keeping the land clear of charlock and other cruciferous weeds must contribute to the spread of the disease, for such plants are affected as well as turnips.

A method of suppressing the disease that is generally successful is to arrange the rotation in such a way that a turnip or similar crop does not occupy the land oftener than once in eight years. In the four-course shift, for instance, it may be possible to put half the fallow break under potatoes or mangolds, and if this be done turnips will not come on the same land oftener than once in eight years, and this in time should effectively banish finger-and-toe. A similar result will be got by keeping land in grass for three or four years. Even the extension of a four or five-course to a six-course rotation will do much to reduce the severity of attacks of finger-and-toe. Needless to say, no method of prevention will have much effect unless farmers also take care to avoid carting diseased turnips or tainted dung on to land under treatment.

Experiments have shown that acid manures encourage finger-and-toe, and this fact should be borne in mind in the cultivation of land that exhibits a tendency to this disease. Phosphatic manures to use, under these circumstances, are Basic Slag, Bone Meal, or Precipitated Phosphate.

Of late years several so-called disease-proof turnips have been put on the market, and, though all are certainly not immune to disease, some are markedly resistant.

4, Whitehall Place, London, S.W.,
October, 1902.

Revised, March, 1912.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Tuberculosis of Poultry.

Tuberculosis is one of the most common diseases of fowls, turkeys, pheasants and other birds. It is a frequent cause of loss to poultry owners in some parts of this country. It has been spoken of as "liver disease," but is only one of *several* liver diseases. Avian tuberculosis is world-wide in its distribution.

Symptoms.

Affected fowls become anaemic, thin, emaciated, and they lose weight. Their appetite is impaired, and erratic feeding is noticeable. The comb and wattles and mucous membranes become pale, and there is usually persistent diarrhœa. As a result of extreme emaciation, which is the most noticeable symptom, the bones become very prominent.

Post-mortem appearances.

The flesh is scanty and the muscles pallid. The liver is dotted all over with small pale spots, or larger patches of a white, grey or yellow colour. The spleen is usually enlarged and beset with small or large tubercles. The intestines and the lymphatic glands of the mesenteries may be also the seats of tubercular deposits. Tubercles may likewise occur on the skin. There are very rarely small tubercules in the lungs.

Cause.

The exciting cause of the disease is a bacillus which may be considered a variety of the bacillus of mammalian tuberculosis. It gains entrance with the food, fouled by means of droppings of the affected birds.

Prevention and Remedy.

1.—The most frequent source of infection is the poultry-house or yard, which receives the droppings of the affected birds, these droppings containing bacilli. Damp, dirt, and absence of sunlight greatly favour the spread of the disease. It is necessary that there should be good ventilation and strict cleanliness in the runs and sheds.

2.—All diseased birds should be killed and buried in lime. The house where they have been should receive several applications of disinfectant, and the tainted run should be dug over and heavily dressed with quick-lime.

3.—Many months should elapse before birds are put back in old quarters that have been cleaned. It is best to clear off all stock where this disease breaks out, and make a fresh start with new stock later. Strong and healthy birds should be carefully selected and put into a new house and run, and if any show indications of disease, they should be removed at once and the house disinfected with chloride of lime ($\frac{1}{4}$ lb. to 1 gallon of water). In this way a disease-free stock may be obtained, and until this is accomplished all that can be done is to observe all possible sanitary precautions.

NOTE.—Until April, 1908, this leaflet was known as *Liver Disease of Poultry.*

4, Whitehall Place, London, S.W.
January, 1903.
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Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 19 leaflets dealing with Diseases and Insect Pests of Farm Animals may be obtained from the same address, price 1d. post free.

BOARD OF AGRICULTURE AND FISHERIES.

Rations for Farm Stock.*

In the judicious blending of the home-grown foods of the farm with purchased foods lies the chief factor in the economical feeding of live stock.

The table on page 2 contains a list of the more important feeding stuffs, most of which have been used in forming the rations hereinafter described, with the percentage of digestible nutrients which they contain. By "digestible" is meant the proportion of the constituents that is actually absorbed into the system, and which therefore performs work, produces meat or milk, or maintains heat.

The most important nutrients in foods are (*a*) *albuminoids* or *proteids*, (*b*) *fats*, and (*c*) *carbohydrates*.

The Albuminoid Ratio.

One pound of fat goes as far in heat production or fat formation as about $2\frac{1}{2}$ lb. of carbohydrates, so that to express the fats in terms of carbohydrates they must be multiplied by $2\frac{1}{2}$; and the ratio of the albuminoid matter in any food to this carbohydrate value is called the Albuminoid Ratio of that food. For example, the albuminoid ratio of oats is said to be 1 to 7·1, that is 1 part by weight of albuminoid matter to 7·1 parts of fat and carbohydrates both expressed in carbohydrate value, or, as the farmer might say, one part of flesh-forming food to about 7 of fattening food.

This ratio is arrived at by referring to the table for the composition of oats, which we see contain 8 per cent. of digestible albuminoids, 4·0 of fat, and 47·4 of carbohydrates. To find

* Condensed, with some modifications, from the Journal of the Board of Agriculture, Vol. IX., page 150 (September, 1902). This leaflet may be regarded as supplementary to No. 74 on the Purchase of Feeding Stuffs, to which reference may be made as regards the functions of food-constituents and the peculiarities of the more important feeding stuffs.

the albuminoid ratio from these figures we multiply 4·0 by 2·5 to bring the fat to carbohydrate value, and add the result to the 47·4 of carbohydrate, getting a total of 57·4; then dividing this figure by 8 (albuminoids) we get as quotient 7·1, or an albuminoid ratio of 1 to 7·1. Expressed in arithmetical form the formula is $(4{\cdot}0 \times 2{\cdot}5 + 47{\cdot}4) \div 8 = 7{\cdot}1$. A ratio is spoken of as narrower or wider according as the difference between the two numbers is less or more; thus, 1 to 4 is a narrower ratio than 1 to 8.

DIGESTIBLE CONSTITUENTS IN THE COMMONER FEEDING STUFFS.—(Chiefly German figures.)

Feeding Stuffs.	Albuminoids.*	Fats.	Carbohydrates and Fibre.
	%	%	%
Decorticated Cotton Cake ...	41·3	8·6	16·3
Undecorticated Cotton Cake ..	18·1	6·1	17·4
Linseed Cake	28·8	7·9	29·7
Cocoa Nut Cake	16·7	8·2	41·4
Linseed	19·4	34·7	20·1
Beans	22·1	1·2	48·2
Peas	19·4	1·0	52·4
Dried Grains	15·1	6·6	32·7
Wet (fresh) Grains	3·7	1·5	8·6
Bran (wheat) coarse	11·3	3·0	39·7
Wheat	10·2	1·2	64·4
Oats	8·0	4·0	47·4
Barley	6·6	1·9	63·7
Rice Meal	6·8	10·2	38·2
Maize	7·1	3·9	67·0
Malt Dust (combings) ...	18·5	1·1	38·6
Hay (average meadow) ...	5·4	1·0	40·7
„ („ clover)	8·5	1·7	37·3
Oat Straw	1·3	·5	37·4
Barley Straw	·9	·5	40·3
Bean Straw	4·0	·5	36·0
Pea Straw	4·3	·7	32·2
Locust Bean Meal	2·7	1·1	74·2
Potatoes...	1·1	—	18·9
Swedes	1·3	—	10·0
Turnips	·8	—	5·8
Mangolds	1·1	—	10·0
Treacle (Molasses)	5·4	—	54·9
New Milk	3·3	3·4	4·6
Buttermilk	3·8	1·1	4·0
Separated Milk...	3·8	·2	4·7
Whey	·9	·2	4·9

* The term "Albuminoids" as used here includes in most cases a certain amount of non-albuminoid nitrogenous substances which are of no value as flesh-formers.

In treacle the whole of the nitrogen is non-albuminoid; in potatoes, swedes, turnips, and mangolds, about half is non-albuminoid. In the other foods the proportion of non-albuminoids is small

Principles for Compounding Rations.

In devising rations for farm stock the following principles should be observed :—

1. The albuminoid ratio required by a sucking animal is about 1 to 4, as in new milk; by milking cows and by half-grown cattle, sheep and pigs, growing and fattening at the same time, 1 to 5 or 6; and by an adult animal simply fattening, or by a working horse, 1 to 8. Adult fattening animals may, however, give good results on widely different albuminoid ratios.

2. Ruminant animals, as cattle and sheep, require bulky matter in their diets, such as grass, hay, straw, and roots, and are well capable of dealing with crude fibre like that contained in straw and hay. Pigs, however, require a more concentrated food, and are not adapted for feeding on crude fibre. Horses are capable of digesting corn quite as well as or even better than sheep and cattle, but they make less use than ruminants of the nutrient constituents of straw, grass and hay.

3. Cows require a somewhat relaxing diet, so that, when grass is not available, roots, meadow hay, bran, or small quantities of linseed or treacle are relied on for keeping them right in this respect.

4. The bare maintenance diet of a full-grown average-sized horse, ox or dry cow is about 8 lb. to 10 lb. of digestible dry matter a day, on which the animal neither gains nor loses weight. Rather more than this is sufficient for an average-sized adult sheep for a week. When fattening, or working, or when yielding a full supply of milk, these animals will often eat twice as much.

It may at once be remarked that although the percentage of digestible constituents, as stated in the foregoing table, has been given to one place of decimals, such fine distinctions are entirely obliterated by the natural variations in the composition and character of the foods themselves, as well as by the peculiarities of the animals consuming them. Again, although many of the following rations have been calculated with much arithmetical detail, this has been done for the purpose of demonstrating exact methods, and not for slavish imitation. Experimental work, too, has shown that the same result may be obtained from widely differing albuminoid

ratios. But though great nicety of detail need not be insisted on, the composition of the rations should be taken as a general guide in the selection of diets for the various classes of farm animals.

Daily Rations for Cows in Full Milk.

Good pasture grass in May has an albuminoid ratio as narrow as 1 to 4, which two months later is widened to 1 to 7; hence it is seen how excellently adapted grass is for spring-born lambs, calves, and foals, and for milking cows, ewes and mares during the early part of the summer, and why it should be improved for them later on by an addition of more albuminoid matter. Up to the end of June, then, good pastures supply food sufficiently high in albuminoids to enable the cow to milk at her best. By the end of July, however, the albuminoid ratio of grass is only about 1 to 7, and later on still wider, instead of 1 to 5 or 6 (about what is required by a cow in full milk); therefore, in order to bring up the albuminoids to the right standard, the addition of some food, like decorticated cotton cake, is necessary for all summer and autumn calving cows soon after they have calved. Thus :—

Lb.		Albds.	Fat.	Carbo-hydrates.
104	Grass (in August) ... =	2·08 lb.	·52 lb.	14·68 lb.
2½	Decorticated Cotton Cake =	1·03	·22	·41
			·75 × 2·5 =	1·85
		3·11		16·94

Ratio 1 to 5·4 (nearly).

Commencing with 1 lb. a day in July, the cake would gradually be increased on ordinary pasture to 2½ lb. by the end of August. For cows that have calved in winter and early spring, and by this time are naturally going off their milking, this addition of cake is unnecessary, though it would benefit the land; neither is it necessary when cows are put on aftermath full of clover. Some pastures produce very soft butter in June, and an addition of 1 lb. of decorticated cotton cake, though not otherwise required, would have the effect of considerably improving the consistency of the butter.

In this and the following winter-rations it is assumed that the cow—an average shorthorn weighing from 11 to 12 cwt. —will require about 3 lb. of digestible albuminoids and fully 16·5 of digestible carbohydrate-equivalent a day, which gives a ratio of 1 to 5·5. As cows under similar conditions practically eat in proportion to their weights, these rations may be modified to suit smaller cows by simply reducing the quantity of each food-stuff in a ration

proportionately, and the ratio will, of course, remain the same. Thus, taking an ordinary Ayrshire cow's weight at 900 lb. as against 1,200 of the shorthorn, she will require as a diet three-fourths of the following shorthorn rations; and assuming a Jersey cow to weigh 800 lb. she will require two-thirds of these rations as a daily allowance. This assumption is sufficiently accurate for most practical purposes, though, strictly speaking, a small animal requires relatively more food than a large one.

In arranging a cow's ration from home-grown and purchased foods, the farmer will be largely guided by the quantities at his disposal and market prices. He should then, by way of a start, write down approximately the weights of roots, long fodder, and meal that a cow will require, omitting for the moment the highly albuminoid food, and remembering that the roots will be somewhere between 2 and 4 stones, the fodder about $1\frac{1}{2}$ stones. and the "trough" food from 6 to 10 lb., part of which will probably be home-grown corn meal and part a highly albuminoid purchased food. He should next calculate the constituents—albuminoids, fat, and carbohydrates—by the Food Table, and see how much short the albuminoids are of 3 lb., and supply the deficiency by means of the cake or other purchased food. When all is totalled up, he will probably find that a little adjustment of weights is necessary to get exactly the 3 lb. of albuminoids and the 17 lb. of carbohydrates required. Bearing in mind the following points the adjusting will not be difficult, viz., that straw will affect the carbohydrates without materially affecting the albuminoids, that the first eight foods named in the Table mainly influence the albuminoids, and that roots, hay, and corn meals affect both the albuminoids and carbohydrates nearly proportionately. Take a case by way of illustration:—A farmer thinks he can afford his cows 3 stones of swedes a day, to be given in two meals. As far as his fodder is concerned he knows he is somewhat short of hay as compared with straw, and he therefore decides to give one foddering a day of meadow hay and two fodderings of oat straw of about 7 lb. each. About half the trough food he intends to consist of crushed oats, say 4 lb., the remainder of decorticated cotton cake; he then writes down:—

42 lb. swedes.
7 ,, hay.
14 ,, oat straw.
4 ,, crushed oats.

and calculates their constituents by the Table.

Thus, calling the figures pounds, the decimal point may be removed two places to the left to get the weight in 1 lb. of the food instead of in 100 lb., and the figures multiplied by the number of pounds of food taken to get the weight of each

constituent in the weight of food taken—in practice it is better to move the point after multiplying instead of before as has been done here. Then in 42 lb. swedes he gets :—

·013 × 42 = ·546 albuminoids.
·10 × 42 = 4·200 carbohydrates.

For the sake of simplicity the third figure to the right of the point may be disregarded if it be less than five, while if it be five or more a unit may be added to the second figure after the point.

In the same way the 7 lb. of hay give :—

·054 × 7 = ·378 or ·38 albuminoids.
·01 × 7 = ·07 fat.
·407 × 7 = 2·849 or 2·85 carbohydrates.

the 14 lb. of straw :—

·013 × 14 = ·182 or 18 albuminoids.
·005 × 14 = ·07 fat.
·374 × 14 = 5·236 or 5·24 carbohydrates.

and the 4 lb. crushed oats :—

·080 × 4 = ·32 albuminoids.
·040 × 4 = ·16 fat.
·474 × 4 = 1·896 or 1·90 carbohydrates.

The albuminoids now total up to 1·43 lb. which, subtracted from 3, leaves 1·57 lb. to be supplied by means of the decorticated cotton cake. Now 1 lb. of cake contains ·41 of albuminoids, therefore 4 lb. will fully supply the deficiency, and we get the following ration :—

Lb.			Albds.	Fat.	Carbo-hydrates.
42	Swedes	=	·55	—	4·20
7	Hay	=	·38	·07	2·85
14	Oat Straw	=	·18	·07	5·24
4	Oats	=	·32	·16	1·90
4	Decorticated Cotton Cake	=	1·64	·34	·65
				·64 × 2·5 =	1·60
			3·07		16·44

or a ratio of 1 to 5·4 nearly. The great advantage of working out a ration in this way is to ascertain exactly the amount of trough food required. This will always include the chief albuminoid food, which is at the same time the most expensive, and the one to be purchased unless peas or beans are grown on the farm. The concentrated foods should be accurately weighed at the commencement; afterwards they may be measured by means of a marked bucket. In actual practice the roots and hay after once being weighed would be guessed at, and the straw would probably be given less carefully than the hay, especially at the night foddering, to satisfy the appetite of beasts more hearty than the others;

any straw remaining in the morning would be drawn back as litter.

The following points should be borne in mind in connection with the feeding of dairy cows:—(1) The diet should not be monotonous; occasional changes of food during a long winter are advantageous, but these changes should be effected gradually. (2) Swedes, turnips, cabbage, rape, kohl rabi, mangolds, carrots, and parsnips all afford suitable green winter food for cows. For practical purposes these foods are much alike in nutritive qualities, though parsnips, carrots, and moderate sized mangolds are rather superior to the rest. Cabbages, carrots, and mangolds are probably the best where first-rate butter is desired, care being taken, in the case of cabbage, to remove the dead and bruised leaves before feeding. To prevent tainted dairy produce all roots and green food, including silage, should be given immediately after milking. Potatoes, when steamed, are a suitable food for cows; they are much richer in carbo-hydrates than the other foods above named. (3) Mixtures of two or more concentrated foods are more serviceable and more economical than one alone. The amount of concentrated food should, if possible, bear some relation to the quantity of milk yielded. Cows that are in full milk will receive, say, 10 or 12 lb. of cake and corn per day, whilst cows that are nearly dry will have their allowance proportionately reduced. (4) The water supply should be adequate and of good quality. (5) Cows should be allowed access to rock-salt. (6) The food requirements are influenced by the temperature of the air. Cattle-houses should be kept at a temperature of about 56° to 58° F. Efficient ventilation, but with the avoidance of cold draughts, should be carefully attended to. (7) Feeding should be done regularly and quietly, and the animals should be fed in the same order at each meal. (8) The palatability of the diet should be considered. Upon this point largely depends the amount of food consumed, and with all ruminant animals those that eat most usually thrive best. (9) Both the quantity and quality of a cow's milk are dependent more upon her breeding or natural capacity than upon the food which she consumes. Liberal and careful feeding, exercised upon a cow possessing the required potential capacity, will enhance her useful functions. The feeding, however, affects the quantity of her milk rather than the percentage of solids in it, and in this way good feeding increases the total amount of butter or cheese produced.

The following are types of rations for the different kinds of stock, and for use on different classes of farms. They are given merely as examples and should be modified to suit special circumstances such as the supply and price of feeding stuffs, &c.

Winter Rations for Milk Cows.

(I.) Farm largely Arable.

(a.) *Where Milk is Sold.*

Lb.	
1.—56	Swedes.
20	Oat Straw.
5½	Decorticated Cotton Cake.

Lb.	
2.—56	Swedes.
16	Oat Straw.
4	Crushed Oats.
4¾	Decorticated Cotton Cake.

(b.) *Where Butter is Made.*

Lb.	
3.—42	Swedes or Cabbages.
20	Oat Straw.
4	Crushed Oats, or 3 lb. Dried Grains.
5	Decorticated Cotton Cake.

Lb.	
4.—28	Mangolds or Carrots.
22	Oat Straw.
4½	Crushed Oats.
5½	Decorticated Cotton Cake.

On a farm that is largely arable, roots and straw would be abundant and hay comparatively scarce. Rations 1 and 2 would contain too much swedes to make good butter. No. 2 is specially adapted for a light-land arable farm where turnips would be largely grown, but the straw would be short in growth. No. 4 might be used after the New Year, when the swedes are finished and the mangolds ripe. It would be suitable also for a farm growing plenty of straw, and mangolds and carrots rather than swedes.

(II.) Farm half Arable.

Lb.	
5.—35	Swedes.
7	Hay.
14	Oat Straw.
3½	Maize Meal or 4 lb. Crushed Oats.
4½	Decorticated Cotton Cake.

Lb.	
6.—30	Swedes.
7	Hay.
14	Oat Straw.
4	Cocoa Nut Cake.
5½	Bean Meal.

Lb.	
7.—28	Mangolds.
7	Hay
14	Oat Straw.
4	Maize or Barley Meal.
5	Decorticated Cotton Cake.

Lb.	
8.—42	Swedes.
7	Hay.
14	Oat Straw.
5	Dried Grains.
3	Decorticated Cotton Cake.

Lb.	
9.—28	Mangolds.
6	Hay.
11	Oat Straw.
4	Wheat Meal.
8	Bean Meal.

On a half arable farm, one foddering of hay a day could probably be spared the cows, and the more complex the mixture the better it seems to nourish the beasts, and the more appetising it is. Of the rations here given No. 5 has invariably proved the best at the Cumberland-Westmorland County Farm for yielding milk, although the ratio of this diet is the same as the others; and this at

once suggests that foods have a subtle influence on each other in the matter of digestibility. It has been discovered that starchy matter added to straw reduces its digestibility, while oily food, if it does not promote, certainly does not check it. No. 9 consists of foods which are largely grown on clays or clay-loams, and is therefore well adapted for use on strong-land farms, and it has the merit of not necessitating the purchase of any imported food. On the other hand, it holds little fat, but contains much starch, and, therefore, in accordance with the statement just made, its straw will not be so easily digested as in diets containing cotton or other oil cake. No. 6 would suit a farm having but few swedes for consumption, and No. 7 is adapted for spring feeding. If the market price of oats were good and maize or dried grains were cheap, it might be more profitable to sell oats and buy these foods.

(III.) Farm about one-third arable.

Lb.
10.—28 Swedes, Cabbages or Mangolds.
14 Hay.
7 Oat straw.
4 Maize.
4 Decorticated Cotton Cake.
or
5 lb. Middlings.
$3\frac{3}{4}$,, Decorticated Cotton Cake.
or
5 lb. Crushed Oats.
3 ,, Undecorticated Cotton Cake.
3 ,, Linseed Cake.

On a farm of which one-third is arable, hay would be more abundant than in the case of (I) and (II), while roots and straw would be less so. Consequently, the rations included under No. 10 provide for two fodderings of hay and only one of straw, with a smaller quantity of roots.

(IV.) Grass Farms.

Lb.
11.—28 Mangolds.
28 Hay.
4 Decorticated Cotton Cake.

Lb.
12.—30 Hay.
6 Bran.
2 Decorticated Cotton Cake.

Lb.
13.—28 Hay.
10 Dried Grains.
$\frac{1}{4}$ Treacle.

In the case of No. 12 a portion of the hay might be chaffed, mixed with the bran, moistened with hot water, and served in two meals. In preparing No. 13 the treacle should be dissolved in 2 gallons of hot water, mixed with the grains, and served the next day.

Lb.
14.—30 Hay.
2 Maize, Barley, or Wheat Meal.
2 Pea Meal.
2 Decorticated Cotton Cake.
$\frac{1}{2}$ Linseed.

One gallon of boiling water should be poured on the linseed at night, the meals and cake being stirred in next day just before serving, with the addition of a little salt.

In reference to Ration 11, which is intended for a clay farm growing strong meadow grass, it is suggested that a patch of a few acres be ploughed and always kept for mangolds. This root can be grown on the same land year after year quite successfully; one advantage of such a system being that the land is always clean and ready for the crop to be drilled early in the spring. In these rations the laxative element is supplied respectively by the mangolds, bran, treacle, and linseed. Whether the treacle or linseed is absolutely necessary will depend on the nature of the hay. If "herby," that is, containing rib-wort, yarrow, the smaller Umbelliferæ, &c., it may be sufficiently laxative of itself.

The complex mixture of No. 14, with the oil supplied in the cake and linseed, makes it a particularly palatable and digestible diet.

(V.) A Town Dairy.

	Lb.	
15.	24	Hay.
	2	Maize Meal.
	40	Fresh Grains (wet).

Also rations 12, 13, and 14.

In town cowsheds roots, as a rule, are not used in large quantity, if at all, on account of the expense. To keep the cows' relish for their food keen, so that they may be fit for the butcher as soon as they become dry, it is the custom, therefore, to chaff some portion of the hay, scald or steam it, and mix it with the meal or bran, and thus allow the cows two moist meals between the dry ones. Where roots are consumed this is not necessary, for healthy milking cows have good appetites and seem to enjoy thoroughly the chewing of long fodder when alternated with juicy roots. Malt dust is a useful milk-producing food for mixing with chaff, with or without pulped roots.

Maize germ meal and gluten meal are useful foods for dairy cows, and may be used in quantities up to 4 or 5 lb. per head per day along with cake. Care should be exercised in purchasing, as materials sold under these names are found to vary greatly in nutritive properties. They are both products of maize and differ chiefly in the fact that the gluten meal is richer in albuminoids and poorer in carbohydrates than the germ meal.

Fattening Rations for Adult Cattle.

Some of the more general observations made respecting the feeding of dairy cows apply equally to the feeding of fattening cattle. Good feeding is attended with the best results only when exercised upon animals of a good feeding kind. All varieties of roots and green food are suitable for fattening cattle, and may be fed in quantities up to one cwt. per day. The feeding value of the different kinds of roots and of the same kind grown under different conditions

varies very greatly; this fact, together with a similar variation in the quality of straw and hay, enables farmers in some districts almost to dispense with cake and corn, whilst those in other districts are compelled to employ these foods very largely. In the rations given below swedes might be replaced by white or yellow turnips or by cabbages in autumn, and by mangolds in spring.

The so-called fattening period generally occupies about four months, and it is usual to increase the allowance of concentrated food as the process continues. The animals usually receive about 2 or 3 lb. cake and as much corn per head per day during the first month, this allowance being increased by 2 lb. at each consecutive month, making about 10 or 12 lb. of mixed cake and corn per head per day during the last month. In the rations given below the quantities of food are about the average for the whole fattening period, and are therefore greater than is necessary to start with, and less than is desirable to finish with.

The term adult may here be taken to apply to cows and 3-year-old bullocks. For such cattle an albuminoid ratio of 1 to 7 or 8 has been found very suitable, so that $2\frac{1}{4}$ lb. of digestible albuminoids and 16 to 18 lb. of digestible carbohydrates would form a good ration. The following are arranged on this basis:—

Lb.			Albds.	Fat.	Carbohydrates.
1.—100	Swedes	=	1·30	—	10·00
16	Oat Straw	=	·21	·08	5·98
2	Decorticated Cotton Cake	=	·83	·17	·33
				·25 × 2·5 =	·63
			2·34		16·94

2.—100 lb. Swedes.
14 Oat Straw.
$4\frac{1}{4}$ Undecorticated Cotton Cake.

3.—56 lb. Swedes.
20 Oat Straw.
$4\frac{1}{2}$ Crushed Oats.
$2\frac{1}{2}$ Decorticated Cotton Cake.

4.—42 lb. Swedes.
7 Hay.
14 Oat Straw.
4 Maize Meal, or 5 lb. crushed Barley.
$2\frac{1}{2}$ Decorticated Cotton Cake.

5.—28 lb. Swedes.
14 Hay.
14 Oat Straw.
$2\frac{1}{2}$ Crushed Grain.
3 Linseed Cake.

6.—28 lb. Swedes.
14 Hay.
10 Oat Straw.
4 Cocoanut Cake.
$3\frac{1}{2}$ Crushed Barley, or 3 lb. Maize Meal.

7.—30 lb. Mangolds.
8 Hay.
16 Oat Straw.
$4\frac{1}{2}$ Wheat Meal.
$3\frac{1}{2}$ Bean Meal.

8.—28 lb. Hay.
5 Maize Meal, or 6 lb. Barley or Rice Meal.
2 Dried Grains, or $2\frac{1}{2}$ lb. Malt Dust.
$\frac{1}{4}$ Linseed.

Rations 1, 2, and 3 are adapted for farms mainly under the plough, the first two being specially applicable to Scotland, where swedes and oat-straw possess higher feeding value than is the case further south. No. 4 is for a farm half tillage and half grass, Nos. 5 and 6 are for one having about one-third of its land arable, No. 7 is for a farm of strong land where only home-grown foods are used, and No. 8 for a grass farm. As decorticated cotton cake contains a much higher percentage of albuminoid matter than any other cake, less of it is required to level up a food like straw, which is very deficient in albuminoids, to the standard ratio. Being also as a rule somewhat cheaper than linseed cake, rations containing it as the chief nitrogenous food-stuff can be more cheaply compounded than those containing linseed cake. Preference is also here given to cotton cake for butter-making rations, as it produces a firmer, less greasy, and more palatable butter than linseed cake. For finishing off fat cattle linseed cake, however, imparts a "bloom" and "touch" which appear to be incapable of attainment with any other food. For this purpose the cake used should be specially rich in oil. For cattle up to a year old, and sheep up to 6 or 7 months, linseed cake is much the safer one to use, nor should cotton cake be given in large quantities to cows within 3 or 4 months of calving.

In barley-growing districts, barley straw would probably take the place of oat straw in these rations; not being so digestible, as a rule, some allowance can be made by increasing the quantity of meal used. In the rapid feeding of cattle for the fat market it is more necessary to resort to chaffing, scalding, and mixing of foods, than in feeding cows for milk; the craving for food is keener in the latter than in the former, and fattening cattle are found to eat straw that has been chaffed, mixed with pulped roots, and allowed to lie a day before being eaten, or chaff scalded and mixed with meal of some kind, and a sprinkle of treacle, better than in the long dry state. Also, where no roots are available, some hay-chaff scalded or steamed and mixed with the meal or other trough food, and given alternately with long hay, induces the cattle to eat with more relish. Cattle spices or condiments are often used for the same purpose.

Rice meal, when genuine, is a sound and economical food for fattening cattle, and may be used in quantities up to 4 or 5 lb. per head per day, along with cake. Barley bran also is a food that is used by some feeders with good results.

Rations for Young Cattle.

Calves should be kept on new milk for the first two weeks of their lives, after which they may be put on to mixed

new and separated milk. After the fourth week they begin to nibble at hay, and can be well kept on 2 gallons per day of separated milk to which is added 3 tablespoonfuls (2 oz.) of cod liver oil. At 10 weeks the oil may be discontinued, and the calf will then have to depend mainly on the carbohydrates of the hay for the heat and fat-producing matter of its food. A little linseed cake, meal, and pulped swedes in winter, or grass in summer, should gradually be introduced, so that at 6 months old milk may be altogether discontinued if necessary. The calf will now thrive well up to a year old on 1 to 1½ lb. of mixed linseed cake and meal, 4 lb. or more of hay, and 3 to 10 lb. of swedes (or grass in summer) a day, which will give an albuminoid ratio of 1 to 4½ or 1 to 5 according to the proportion of hay and roots eaten. On milk-selling and cheese-making farms, however, separated milk is not available, and recourse has to be had to milk substitutes or calf-meals to rear the heifer calves intended for breeding. There is no difficulty in compiling from our food table a meal that shall closely resemble milk in its digestible constituents, but it cannot be done without at the same time introducing a much larger amount of indigestible matter than occurs in milk; this, and the question of choosing meals that will agree with the calf's stomach, constitute the practical difficulty of rearing calves without milk.

Calf Meals.

The following mixtures have proved to be good milk substitutes, giving an albuminoid ratio about the same as that of new milk :—

1.—Linseed Cake Meal,	14	parts	by weight.
Crushed Linseed	5	"	"
Wheat Flour	2	"	"
Locust Bean Meal	2	"	"

This may be prepared by mixing 3 lb. with 5 qts. of boiling water and a sprinkle of salt, say ¼ oz., for the day's allowance of one calf—given at three meals under three months old, and at two meals above that age.

2.—Linseed Cake Meal,	2	parts.
Oatmeal	2	"
Crushed Linseed	1	"

3 lb. should be mixed with 5 qts. of boiling water over night and stirred and boiled for 10 minutes next morning, and then served at three or two meals with salt and 2 oz. of sugar.

Where a small quantity of separated or skim milk is available :—

3.—8 parts of Oatmeal.
1 part of Crushed Linseed.

In this case $2\frac{1}{4}$ lb. should be scalded over night with 5 pints of boiling water, and boiled for 10 minutes next morning; 5 pints of separated milk should then be added with about $\frac{1}{4}$ oz. of salt and 2 oz. of sugar; this will suffice for one calf for one day.

Weaners on grass require no more than from $\frac{1}{2}$ to $\frac{3}{4}$ lb. mixed linseed cake and meal each per day in addition to grass to keep them in good thriving condition.

Yearling bullocks that are intended to be house-fed for early beef of, say, about 8 cwt. live weight at about 19 months old, should have the diet recommended for calves rising a year old, steadily increasing until they finish with two-thirds of the ration of a full-milking shorthorn cow. The same feeding is suitable for fattening Irish heifers.

At about 15 months old the fattening yearling would in this way be receiving a diet like No. 4; and at 18 or 20 months of age, when finishing for the butcher, a ration like No. 5 would be suitable. The albuminoid ratio in both cases is about 1 to $4\frac{1}{2}$.

4.	5.
21 lb. Swedes.	37 lb. Swedes.
7 „ Hay.	10 „ Oat Straw.
2 „ Oats.	3 „ Maize, Barley, or Wheat.
3 „ Linseed Cake.	3 „ Linseed Cake.
	2 „ Decorticated Cotton Cake.

Yearling store bullocks and heifers turned out to grass in the spring require no extra food, but should come in full of flesh in late autumn. For wintering yearling stores a liberal allowance of turnips and straw, with from 2 to 4 lb. per day each, according to size, of mixed decorticated cotton cake and meal, should be given in order to produce well-grown and "fresh" beasts for the spring store sales. If, however, they are intended for the fat market in the new year, when close upon two years old, they will require more liberal feeding, and by the beginning of December will pay for a ration of five-sixths that of a cow in full milk, such as:—

6.	7.	8.
42 lb. Swedes.	42 lb. Cabbages or Yellow Turnips.	22 lb. Mangolds.
14 „ Oat Straw.	7 „ Hay.	18 „ Oat Straw.
3 „ Maize Meal or 4 lb. Crushed Barley or Rice Meal.	6 „ Straw.	4 „ Crushed Oats
4 „ Decorticated Cotton Cake or 5 lb. Linseed Cake.	4 „ Crushed Oats. 6 „ Dried Grains or 3 lb. Crushed Oats. 5 „ Dried Grains. $\frac{1}{4}$ „ Linseed.	$4\frac{1}{2}$ „ Decorticated Cotton Cake.

As it is mainly on arable farms that winter feeding is followed, roots, straw and corn will for the most part form the home-grown contributions to the rations.

Rations for Sheep.

In Scotland and over a large portion of the north and west of England ewes wintering on grass require no more than a rack of hay, and generally get mangold and turnip-tops thrown out to them, and are run over the root land, after the roots have been pulled and carted off, to clean up small ones and stray leaves. As soon as they lamb they require a ration with an albuminoid ratio of about 1 to 5 or 6 to keep up their milk supply and flesh. This is generally provided in the first three months of the year by means of swedes or mangolds, bean or pea straw, or mixed hay and straw chaff (oat or barley) and peas, linseed cake, oats, bran, &c.

The following rations supply the requirements of seven ewes for one day, or one ewe for a week; the quantity and quality of the digestible matter is almost the same as that of the cow rations, but as the ewe will get nearly all her water from the roots supplied, something like three times as many are given her for a week as to a cow for a day:—

	Lb.			Albds.	Fat.	Carbo-hydrates.
1.—	120	Swedes	=	1·56	—	12·00
	5	Hay and Straw Chaff ...	=	·17	·04	1·95
	5	Linseed Cake	=	1·44	·40	1·49
					·44 × 2·5 =	1·10
				3·17		16·54

Lb.		Lb.	
2.—120	Swedes.	3.—80	Mangolds.
2	Pea Straw.	6	Hay.
2	Hay.	6	Oats.
6	Peas.	5	Bran.
		2	Decorticated Cotton Cake.

When the ewes and lambs are put on a good spring pasture they no longer require trough feeding; but should they be inclined to scour it would be well to continue oats for a while. As the ewe's milk diminishes the lambs should be kept progressing after July with about a pound of linseed cake or cracked peas to every seven lambs per day. When ewes or lambs are placed on clover aftermath they fatten without auxiliary food.

In the case of the various "Down" breeds of sheep in the south of England, lambing usually takes place in January. After lambing the ewes and lambs are folded on roots, and the ewes are allowed about 1 to $1\frac{1}{2}$ lb. of sainfoin or meadow hay per day, and about the same quantity of concentrated food, consisting, say, of linseed cake, peas and

pollards, or dried grains and oats. During the spring months the sheep are folded on rye, trifolium and rape, with an allowance of mangolds. In summer the fold will be vetches and rye grass, and in autumn rape, with a run each day on old leys. As the lambs become independent of milk, the allowance of concentrated food to the ewes is gradually dropped. Dried grains is an excellent food for ewes, and an admixture of malt dust with hay chaff not only supplies extra nourishment, but also renders the chaff more palatable.

Fattening Sheep.

The following points should be considered in the successful fattening of sheep:—(1) A mixture of two or more concentrated foods is better than one concentrated food alone; (2) The allowance of cake and corn should be gradually increased as the fattening process continues, commencing with, say, 2 lb. per head per week, and finishing with, say, 6 to 10 lb. according to the size of the sheep; (3) A monotonous diet should be avoided, and this refers to both green food and trough food; (4) The greater the amount of bulky food consumed, the more rapid and economical will the fattening process be.

Hoggets (tegs) are extensively fattened during the winter on turnips or swedes, and experience has shown that the fattening is done much more economically, and with fewer losses by death, when dry foods are given with the roots, and the roots are cut and measured out to the sheep. The cutting of roots is a much commoner practice in the north than in the south.

Young sheep fattening for the butcher usually consume from 100 to 160 lb. of roots or green food, such as cabbages or rape, per head per week, and from 3 to 8 lb. of hay, or hay and straw. The consumption of concentrated food varies from 2 to 10 lb. per head per week, being on the average about 5 lb. The following is a typical weekly ration for a fattening sheep belonging to one of the larger breeds, such as Hampshire Down or Leicester.

Lb.			Albds.	Fat.	Carbohydrates.
120	Swedes	=	1·56	—	12·00
5	Hay and Straw Chaff ...	=	·17	·04	1·95
3	Crushed Barley	=	·20	·06	1·91
2	Decorticated Cotton Cake	=	·83	·17	·33
				·27 × 2·5 =	·68
			2·76		16·87

Ratio 1 to 6·1.

The following are examples of suitable mixtures of concentrated foods to be given along with green food (including roots) and hay, or hay and straw. The quantities are suitable for one sheep for a week, on the average of the fattening period.

3 lb. Maize.
2 ,, Decorticated Cotton Cake.

3 ,, Dried Grains.
2 ,, Decorticated Cotton Cake, or Linseed Cake.

2 ,, Malt Dust.
2 ,, Maize, or Barley.
1 ,, Decorticated Cotton Cake, or Linseed Cake.

3 ,, Wheat, or 2 lb. Wheat.
1 ,, Malt Dust.
3 ,, Undecorticated Cotton Cake.

3 ,, Peas.
2 ,, Dried Grains, or Cocoa Nut Meal.

Where sheep are growing rapidly, and at the same time putting on flesh—such as is the case with ram lambs to be sold for service at about eight months old—there must be plenty of variety in the diet, and the trough food must be rich in flesh-forming material. A good mixture for this purpose is linseed cake and peas, with or without malt dust.

In certain parts of Scotland sheep are regularly fattened without the addition of hay or straw to the ordinary diet of turnips and cake, &c. The high quality of the roots grown in these districts largely accounts for the success of this system. Where there is a good market for hay, a modification of the system could be followed in other parts of the country by substituting dried grains for a portion of the hay, or by giving dried grains and straw chaff instead of hay.

Rations for Pigs.

The following mixtures of food rations have been used with pigs fed from 10 weeks old, for a period of 18 to 20 weeks, and making from 16 to 18 stones dressed weight. Each has an albuminoid ratio of approximately 1 to 6, and consists of food-stuffs ordinarily used in pig feeding to meet varying farm conditions. The daily allowance will be regulated by the age and size of the pig.

1. 6 lb. of maize meal to 1 gallon of separated milk.
2. 2 lb. of maize meal to 1 lb. of pea meal.
3. 6 lb. of middlings to 1 lb. of pea meal.
4. 6 lb. of boiled potatoes, 3 lb. of ground oats, to ½ gallon of separated milk.
5. 5 lb. of ground oats, 1 lb. pea meal to 1 gallon of whey.

The meal is scalded in bulk and mixed with separated milk, whey, or water as the case may be, at the time of

serving. The pigs are fed three times a day with as much as they will "clean up" each time.

In many parts of the country the most saleable pig is one weighing about 160 lb., or 8 scores dead weight, and this should be attained when the animal is about 8 months old. The pigs are weaned at about 2 months, and for the next 3 months are kept in rapidly-growing store condition. They should be given cooked roots or vegetables of some sort every day, and in addition should receive a thin wash comprising a fair proportion of flesh-forming matter. The diet should have a ratio of about 1 to $4\frac{1}{2}$ or 5.

The following are examples of suitable mixtures of foods for pigs after weaning :—

1. Separated milk or butter-milk, barley meal, and bran or pollards. If 1 gallon separated milk be allowed, the meal and bran would be mixed in the proportion of 5 to 1.
2. Separated milk or butter-milk, maize meal, and bean or pea meal. With 1 gallon separated milk the maize and bean meals would be in the proportion of 4 to 1.
3. Separated milk or butter-milk, maize meal, and wheat meal, the meals being in the proportion of 3 of maize to 1 of wheat.
4. Whey or house wash, barley meal, and bean or pea meal. With 1 gallon of whey the meals should be in the proportion of 2 to 1.
5. Whey or house wash and ground oats.
6. Brewers' grains (fresh), barley meal, and bran or pollards.

Compared with whey, separated milk and butter-milk are both rich in flesh-forming constituents. A mixture of whey and maize meal would be quite unsuitable unless fortified by, say, bean or pea meal.

With regard to the quantity of food required, young pigs of 3 or 4 months old will consume about $3\frac{3}{4}$ lb. of dry food per 100 lb. live weight per day. This quantity of dry food would be supplied by 1 gallon separated milk and about 3 lb. of meal.

After pigs have attained the age of about 5 months the feeding is of a more forcing nature, and from this time the fattening process continues till the animals are slaughtered at the age of 8 or 9 months. The quantity of food required is represented by about $3\frac{1}{4}$ lb. of dry feeding substance per 100 lb. live weight per day, and in order to produce a fair proportion of lean flesh the diet should have an albuminoid

ratio not wider than 1 to 6. The allowance of meal should be gradually increased, and the food should be given of thicker consistency as the fattening proceeds. A pig of 160 to 180 lb. live weight will require about 6 lb. of meal per day, or its equivalent in meal and dairy refuse. The following are suitable daily rations for pigs of this kind :—

1. 5 lb. barley or maize meal, 3 lb. potatoes, 1 gallon separated milk or butter-milk.
2. 6 lb. barley or maize meal, 1 gallon separated milk or butter-milk.
3. 4 lb. barley or maize meal, and 2 lb. bean or pea meal.
4. Equal quantities each of bean, maize, barley, and wheat meals.
5. Barley and wheat meals in the proportion of 5 or 6 of the former to 1 of the latter, with separated milk or butter-milk, and in the proportion of 3 or 4 to 1 with whey or wash.

Pig-sties should be kept warm and dry, as the pig is very susceptible to cold or damp.

Well-bred pigs slaughtered at, say, 8 or 9 months old will weigh usually about 200 to 212 lb. live weight, and they will yield 75 to 80 per cent. of carcase meat.

It is considered that a pig thriving well should yield about 1 lb. of dressed meat for every 5 lb. of meal consumed.

Rations for Horses.

In France and Germany experiments have been conducted for the purpose of ascertaining what constitutes a bare maintenance diet for a horse of 1,000 lb. weight when absolutely at rest; and it was found that 8 lb. of digestible matter, with an albuminoid ratio of about 1 to 8, was sufficient. Good hay alone will give this ratio. As, however, in practice there are but few days in which farm horses will be kept entirely in the stable, and cart horses are usually heavier than 1,000 lb., we may take 10 to 12 lb. of digestible organic matter as about the maintenance diet of a farm horse when not at field work or carting. A heavy farm horse at ordinary work will require a ration supplying about 27 lb. total dry matter. The food should contain, say, 2 lb. of digestible albuminoids and 15 lb. of digestible heat formers, and should have a ratio of about 1 to $7\frac{1}{2}$. The quantity of food required can be readily calculated from the assumption that hay and corn contain about 85 per cent. and 88 per cent. of dry matter respectively.

The following is probably the simplest example of a daily ration for a farm horse :—

Lb.		Albds.	Fat.	Carbo-hydrates.
1.—20 Hay	... ... =	1·08	·20	8·14
12 Oats	... ... =	·96	·48	5·69
			·68 × 2·5 =	1·70
		2·04		15·53

Albuminoid ratio 1 to 7·6.

As a rule, however, a simple diet like the above is not the most serviceable. With a more complex diet the animals will be found to thrive better, and in many cases also the expense is reduced.

It is economical to chaff hay for horses, as they frequently waste it by littering when supplied long in the rack, though possibly a horse given to bolting food would chew it better in the long state. All corn should be crushed or bruised. The feeding should take place regularly with avoidance of long fasts. Occasional changes of food are advantageous, and during busy times when horses are working long hours at heavy work the diet should be of a concentrated character, as horses do not derive the same amount of nourishment from bulky foods that cattle do. In the neighbourhood of London, where farm horses are frequently engaged almost continuously in carting hay and straw to market, it is not unusual to allow as much as 25 lb. per head per day of oats, with only a small quantity of hay chaff. A mixture of maize and beans in the proportion of $2\frac{3}{4}$ of the former to 1 of the latter gives about the same albuminoid ratio as oats, and it will be found that 15 lb. of the maize-beans mixture affords the equivalent amount of nourishment to 19 lb. of oats.

The following are examples of suitable daily rations for farm horses at average work :—

Lb.	Lb.	Lb.
2.—18 Hay.	3.—12 Hay.	4.—18 Hay.
9 Maize, or partly Barley.	5 Oat Straw.	12 Oats.
2 Bran.	6 Oats.	2 Beans.
2 Beans.	6 Maize.	
	3 Beans.	

A full ration for a horse at the busiest time of the year would be :—

Lb.
5.—9 Oat Straw.
6 Hay.
12 Oats.
3 Beans or Peas.
$1\frac{1}{2}$ Linseed.

Farm horses fed on oat straw and oats alone—the plan followed in many northern and western districts—require a very variable quantity of oats, depending upon the character of the straw, which in some localities has a high nutritive value, whilst in others its quality is very low. In any case the oat straw is given *ad libitum*, and the quantity of oats required to supplement it will vary from 14 to 24 lb. according to the quality of the straw, the quality of the oats, the size of the horse, and the character of the work to be done.

Horses that are not at work can be maintained on hay alone. Such a diet, however, fails to keep up that "hard" condition which is necessary if the horse is to be fit for work when called upon. A suitable ration for an idle horse is:—

	Lb.		
6.—	8	Oat Straw.	
	6	Hay.	
	5	Maize (or Maize and Barley)	or 8 lb. Oats.
	2	Beans	

Carrots, swedes, and mangolds are much relished by horses; they are very suitable for idle horses, but to those in work they should not be given in quantities greater than about 8 or 10 lb. a day. A sick horse will often be tempted to eat a few carrots when it will touch no other food.

Mares suckling foals find all the nourishment they require in an early summer pasture; should an indoor ration be required for a mare with a foal, the following is a very suitable one, the albuminoid ratio being about 1 to 6·3:—

	Lb.	
7.—	21	Hay.
	4	Maize Meal.
	5	Oats.
	3	Bran.
	3	Beans.

Half the hay might be given long, the other half should be chaffed and mixed with the maize meal and bran damped, and the oats and the crushed beans given dry. In feeding horses it is a safe rule to remember the saying "*old* oats, *old* hay, and *old* beans long crushed."

The foal will graze with the mare and soon share with her any indoor food she may be getting, and thus prepare itself for weaning. When weaned it should get a little trough food, consisting of ½ lb. oats, and ¼ lb. linseed cake, a day. It would probably be wintered out on the pastures in the

day time, and in a shed or well-aired loose box at night; when brought in at night it should be supplied with a rack of hay and one of the following trough mixtures:—(1) 1 lb. of oats and ½ lb. linseed cake, or (2) ½ lb. oats, ½ lb. bran, and ½ lb. crushed beans. The oats should be crushed or bruised.

4, Whitehall Place, London, S.W.,
February, 1903.

Revised, October, 1908.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 80.

BOARD OF AGRICULTURE AND FISHERIES.

The Use of Artificial Manures.

Some of the points that a farmer may with advantage consider in purchasing artificial manures are set forth in Leaflet No. 72. The present leaflet is designed to supply practical information in regard to the use of these substances.

In reading the following general recommendations as to manuring, the reader should bear in mind that, though the advice offered may be serviceable in the majority of cases, it will not be applicable to exceptional circumstances. Farmers who manure on general principles will, no doubt, usually be right, but those who are dealing with soil of an exceptional character, or with a farm that has been managed in an exceptional manner, may be led very far astray by blindly following general principles. The manuring of meadows may be taken as an example. The teachings of Rothamsted, and of several other experimental stations, show that, as a rule, potash is a most important ingredient in a manurial mixture, and yet there are cases where this substance does harm rather than good when used for meadow hay. For the turnip crop also potash is usually necessary, and its use will leave a profit, though it cannot be said that, in many cases, its presence or absence is a matter of vital importance. There are cases, however, in which potash is the most important element of all in the treatment of this crop; so much so, indeed, that the most liberal applications of nitrogen and phosphates may be absolutely without effect if unsupported by potash.

It is, therefore, the first duty of a farmer to ascertain what the manurial requirements of his own particular holding may be. And not only so, but, if his land be variable in character, he should take steps to become acquainted with the peculiarities of every field. To rest satisfied with less is to conduct his business in a haphazard fashion. His practice may be right, but there is a great chance that it will be wrong, and a serious error in judgment may result in heavy pecuniary loss. To some it may seem an extreme recommendation to make that every farmer should be an experimenter, but nothing less will meet the necessities of the case. What with the extra labour involved in measuring and weighing, and the loss in yield that some of the methods of treatment may entail, experimenting cannot be done without expense; but for ordinary practical purposes five pounds will go a long way towards obtaining information

that may be worth many times this sum. The land must be measured, and the manures must be weighed and properly mixed and applied, and though the experiment cannot be said to be complete till the produce has been weighed, an experienced farmer can often estimate with the eye with sufficient accuracy what the result of his experiments has been.

The set of experiments known as "The Eight Plot Test" is that which gives the greatest amount of information for the number of plots involved. It supplies four answers to each of the three questions: Shall I use (*a*) Nitrogen? (*b*) Phosphate? (*c*) Potash? It may be carried out with any nitrogenous manure (*e.g.*, nitrate of soda or sulphate of ammonia), with any phosphatic manure (*e.g.*, superphosphate or basic slag), and with any potassic manure (*e.g.*, kainit or sulphate of potash). Suppose that the first-mentioned of each of these pairs is employed, and that the crop is turnips, the eight plots may be treated per acre as follows:—

1. No manure.
2. 1 cwt. nitrate of soda.
3. 5 cwt. superphosphate of lime.
4. 3 cwt. kainit.
5. 1 cwt. nitrate of soda and 5 cwt. superphosphate.
6. 1 cwt. nitrate of soda and 3 cwt. kainit.
7. 5 cwt. superphosphate and 3 cwt. kainit.
8. 1 cwt. nitrate of soda, 5 cwt. superphosphate, and 3 cwt. kainit.

When the crop is mature, it will be possible to ascertain the effects of nitrate as follows:—

Compare Plots 1 and 2 for the result of using nitrate alone.

Compare Plots 3 and 5 for the result of using nitrate with superphosphate.

Compare Plots 4 and 6 for the result of using nitrate with kainit.

Compare Plots 7 and 8 for the result of using nitrate with both superphosphate and kainit.

Similar information may be got for superphosphate by taking the plots as follows:—1 and 3, 2 and 5, 4 and 7, 6 and 8; and for kainit by taking Plots 1 and 4, 2 and 6, 3 and 7, 5 and 8. By omitting three plots (2, 3, 4), and having only five (1, 5, 6, 7, 8), information sufficiently serviceable for most purposes will be obtained, for the test will show the effect (*a*) of using a general dressing (compare Plots 1 and 8), (*b*) of omitting nitrogen (compare Plots 8 and 7), (*c*) of omitting phosphate (compare Plots 8 and 6), (*d*) of omitting potash (compare Plots 8 and 5). By adding a few plots to either of these sets, supplementary information may be got in regard to the best kind of nitrogen, phosphate, or potash; and, further, as to the best quantity. Each plot should be $\frac{1}{40}$th of an acre or 4 rods.

Further information as to experiments of this kind is given in a pamphlet* which may be obtained free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W.

Manurial Treatment of the More Important Crops.

The basis of all systems of manuring should be dung. This does not mean that this substance should be applied concurrently with artificial manures, but merely that land from which crops are taken should periodically receive a fair dressing of this fertilizer. Where straw, hay, and roots are consumed on a farm, enough dung will be produced to allow of about one-fourth or one-fifth of the area of arable land and meadows being dressed annually with 10 to 15 loads per acre. As regards the arable land, the dung is applied in some districts to the roots (North of England, Wales, Scotland), in others it is given to the wheat (where bare-fallowing is practised), while elsewhere it may go on to the barley stubble for the seeds hay (Suffolk), or be used in other ways. Although on land that naturally grows strong straw the supply of dung may alone maintain a farm in fair fertility, it seldom, if ever, happens that the home-made supplies suffice to produce maximum crops throughout a rotation. For this reason it is found to be profitable to purchase artificials, which, however, should be regarded as a supplement, not as a substitute, for the natural fertilizer. The larger crops that these artificials produce mean, of course —if the crops are consumed at home—a larger dung-heap, so that when once a farm has been brought up to a high state of fertility it is prudent to curtail the manure bill.

Cereals.

Wheat receiving 10 loads or upwards of dung per acre seldom needs artificials, and the same is usually true where this crop follows a well-dunged root crop, or a good clover root. Where artificials are used, nitrogen is the most important element, and, as wheat usually occupies strong land, nitrate of soda (1—2 cwt. per acre) is preferable for use in spring to either sulphate of ammonia or organic manures. Sometimes it is desirable to help a weak plant in autumn, and then 1 cwt. of sulphate of ammonia or 2 cwt. of rape dust or fish meal may be used. The residues from applications of phosphates to the root crop usually make the direct use of such manures for wheat unnecessary ; but there are many exceptions to the rule, and, especially on the lighter classes of wheat soils, and in late districts, 2 cwt. per acre of superphosphate applied in autumn, by improving quality and hastening maturity, may be profitable. Potash is seldom of importance in the manurial treatment of this crop.

* *Manurial and other Agricultural Experiments.*

Barley responds readily to nitrogenous dressings, but as it is easily laid, and is often put in with "seeds" which thrive best under a light crop, it is not often top-dressed. Moreover, barley generally follows a well-manured root crop, often folded with sheep, so that the land is in good condition. It is also to be remembered that the grain is apt to be horny or flinty when too much nitrogenous manure is applied, so that an increase in yield may be more than discounted by a reduction in quality. A fine sample of barley, though a small yield, is often got after a wheat crop, largely because the soil is thereby to a great extent depleted of its surplus supplies of nitrogen.

If the field is in low condition, and especially if a short-stemmed, stout-strawed variety is grown—more particularly in a district where the best class of brewing barley cannot be hoped for—a moderate dressing of nitrogenous manure may be given ; and, as barley soils are usually light, sulphate of ammonia ($\frac{3}{4}$—1 cwt. per acre) will suit better than nitrate of soda. To improve the quality, though also to add to the bulk, both phosphates and potash may frequently be used with advantage, but it is very necessary for the farmer to determine the point by experiment. On typical barley soils dissolved bones and Peruvian guano are also suitable. A barley manure may therefore consist of about (per acre) :—

3 cwt. dissolved bones
or $1\frac{1}{2}$ cwt. Peruvian guano
or $\frac{3}{4}$ cwt. sulphate of ammonia, with
2 cwt. superphosphate, and
2 cwt. kainit.

All may be applied with the seed and the last three may be mixed immediately before application.

Oats are often grown on the poorest classes of tillage land, and, moreover—coming, as they do in many cases, before roots, and therefore removed as far as possible from the point in the rotation when dung is used—they find but small supplies of food in the soil. They are frequently sown after land has been some years in grass, and when, consequently, there is a tough sod ; and a heavy straw crop can do much to mellow the soil and make it work down kindly for the following root crop. If, as is often the case, oats are grown in a damp district, sulphate of ammonia (say 1 cwt. per acre) may be used. In other cases, and especially if a weak plant is to be helped by top-dressing, nitrate of soda (1—$1\frac{1}{2}$ cwt.) will be more serviceable. Phosphates will not usually add much to the bulk, but they will make harvest somewhat earlier, and in a typical oat district this is of importance. Two cwt. of superphosphate may therefore often be used with advantage. Only on very light land is it likely that potash will pay on this crop.

Experiments which have been carried out in various parts of the country tend to show that for use on cereals the two new nitrogenous fertilizers, calcium cyanamide and nitrate of lime, are about equal in effect, weight for weight of nitrogen, to nitrate of soda and sulphate of ammonia. On soils deficient in lime, calcium cyanamide should be used. It would be more suitable than sulphate of ammonia.

Rye is usually grown on the lighter and poorer soils and may be treated as for oats.

Maize is now grown to a considerable extent for fodder.* It should either follow a well-dunged root crop or receive a moderate direct dressing of dung, the land being generally prepared as for roots. In either case the artificials may consist of 1 to 2 cwt. of nitrate of soda or sulphate of ammonia, and 2 to 3 cwt. of superphosphate.

In the absence of farmyard manure artificials alone may be employed, the dressing per acre consisting of 1 cwt. sulphate of ammonia, 3 cwt. superphosphate, and, on light soil, 3 cwt. kainit, applied before sowing; a month later 1–2 cwt. nitrate of soda should be given as a top dressing.

Green and Root Crops.

Mangolds: the basis of manuring for this crop should be 10 to 18 tons of dung per acre, applied in autumn if the land be clean, or in spring. Supplementary to this manure nitrate of soda is the most important artificial, and of this 1 to 1½ cwt. per acre is the normal allowance, though up to 4 cwt. has given good returns; half may be given at the time of sowing and half as a top-dressing a week after thinning, or later. Three cwt. of superphosphate, and 3 cwt. of kainit should be given at the time of sowing. Half the nitrate of soda and the whole of the superphosphate may be replaced by 3 cwt. of dissolved bones. If basic slag be used in place of superphosphate, it should be put on broadcast in February. One of the most conspicuous results at Rothamsted consists in the superior action of nitrate of soda as compared with ammonia salts on this crop. Under some circumstances, however, sulphate of ammonia may do better. Each farmer should determine for himself which of the manures suits his land best. Salt sometimes acts well on mangolds, and 2 to 3 cwt. per acre may be given.

If the crop be grown without dung, the artificials above indicated should be increased by one-half, and may sometimes even be doubled.†

Turnips, Swedes, and **Kohl Rabi,** may, in general, be treated like mangolds, except that they need not get so much dung or nitrogen, but they should receive relatively

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* See Leaflet No. 73 (*Cultivation of Maize for Fodder*).

† See also Leaflet No. 169 (*Cultivation of Mangolds*), and *Special Report on the Manuring of Mangolds*, price 3*d*.

more phosphates. If 10 or 12 tons of good dung be used the supplementary artificials need not exceed ½ cwt. nitrate of soda and 3 cwt. superphosphate. Even this moderate allowance will often fail to pay directly, but the superphosphate will have some influence on the next crop. If the land be very light, kainit up to 3 cwt. per acre may be used not so much for its effect on the roots as for its influence on the clover that may follow.

In the absence of dung these allowances should be at least doubled ; or, better still, ½ cwt. of sulphate of ammonia may be applied with the seed, and ½ cwt. nitrate of soda may go on a month later as a top-dressing. If the land be very light, fish meal, rape dust, or dissolved bones may partly replace the more soluble substances. If the land be at all disposed to Finger and-Toe* it is well not to use either superphosphate or dissolved bones. An equivalent expenditure on basic slag (or bone meal, very finely ground if the land be sandy) will, on such land, produce a sounder crop. Precipitated phosphate is also an excellent fertilizer under these circumstances, but it is not always easy to procure. Potash in some form is usually necessary in the absence of dung, and in many cases it is absolutely essential. Four or 5 cwt. of kainit, or a corresponding quantity of sulphate or muriate of potash, will usually suffice. If part or all of the crop is to be folded on the land, the manurial treatment may be less liberal.

Rape, Thousand-headed Kale and **Mustard,** speaking generally, require more nitrogen and less phosphates than the last-mentioned crops, but on fen land the nitrogen need only be used sparingly. As these crops are generally consumed where they grow the land need not get farmyard manure. Rape sown on stubble may get 2 or 3 cwt. of superphosphate per acre.

Cabbages are treated in a variety of ways, but as a rule they should get a liberal dressing of dung, together with 3 or 4 cwt. of superphosphate and as much kainit. When the plants are fairly established, 2—3 cwt. per acre of nitrate of soda, applied in "pinches," or by means of a spoon round the base of each separate plant, should be given. This is a somewhat slow process, but to broadcast nitrate on a crop, where the plants may be two or three feet apart, must be wasteful of manure.

Potatoes, being worth so much more than an equal weight of roots, should be more liberally treated as regards manure. Under ordinary circumstances farmyard manure (15 to 20 tons per acre) should be the basis, supplemented by much the same kind and quantity of artificials as in the case of mangolds, omitting, however, any top-dressing.

* See Leaflet No. 77 (*Finger-and-Toe in Turnips*).

Kainit is not the best potassic manure for potatoes, sulphate and muriate of potash proving superior in their effects both as regards quantity and quality.

If there is abundance of organic matter in the soil, as, for instance, when potatoes are taken after a two or three years ley, artificials alone will, in many cases, grow a full crop of potatoes.

In view of the valuable nature of the crop, and especially in the case of early potatoes, farmers can not only afford to manure liberally, but it will also pay to employ more complex dressings than in the case of less valuable crops. The following dressing has given excellent results and will be found generally serviceable :—

½ cwt. nitrate of soda.
½ cwt. sulphate of ammonia.
2 cwt. dissolved bones.
2 cwt. superphosphate.
1 cwt. sulphate of potash (containing about 50 per cent. potash).

It would be an improvement, though involving a little more trouble and expense, to use only ¼ cwt. of nitrate of soda and ¼ cwt. sulphate of ammonia, and to add ½ cwt. of fish guano, and ½ cwt. of Peruvian guano. Five to 8 cwt. per acre of such a dressing may be used with, or double this quantity without, a liberal dose of dung.

(See also Leaflet No. 173, *Potato Growing*.)

Carrots and **Parsnips** are usually grown on light or peaty land, and a good artificial dressing would consist of 1 cwt. of sulphate of ammonia, 4 cwt. of superphosphate, and 4–6 cwt. of kainit. Whether farmyard manure should be directly used will depend on the character of the land and its previous treatment.

For 50 miles round London, and also in other parts of the country, soot at the rate of 5–10 cwt. per acre is largely used, especially on crops that are apt to suffer severely from the attack of insects and slugs, *e.g.*, cabbages, turnips, carrots. Soot supplies nitrogen, of which about 5 cwt. of soot hold as much as 1 cwt. of nitrate of soda ; besides acting as an insecticide and fertilizer soot darkens the soil, and from the point of view of temperature this is often an advantage.

Leguminous Crops.

Beans and **Vetches** often receive dung, but although this substance will markedly benefit such crops, it can usually be more advantageously employed otherwise. In an artificial dressing for these and other leguminous crops, nitrogen should be omitted, not because it may be altogether inoperative, but simply because such crops generally grow sufficiently well without it. Five to 7 cwt. of superphosphate or basic slag, and about 4 cwt. of kainit, or an equal money value of some other potassic manure will usually prove a serviceable dressing.

Peas should receive no dung, partly because its nitrogen induces the growth of weeds, which are not easily kept down in this crop, and partly because it forces a rank growth of straw and retards the filling and ripening of the pods. The phosphates recommended for beans and vetches may be used on peas, while the potash—peas being generally grown on light land—may be somewhat increased.

Beans, vetches and peas are all lime-loving crops, and for this reason basic slag is well suited to their requirements. On soil poor in lime dressings of lime will produce a good effect, but it is better only to grow these crops on land naturally well supplied with this substance.

Sainfoin, Lucerne* and **Red Clover** do best when they are put in after a well dunged and thoroughly well cleaned root crop, but they should not be directly treated with dung. Phosphates and potash are all-important for the two latter crops. There should, to begin with, be a considerable residue of these substances in the land, the result of dressings applied to the previous crop—usually roots. Such residues are incorporated with the soil in a manner that is difficult of attainment with direct dressings. As regards immediate applications, some 5 cwt. of basic slag and $2\frac{1}{2}$ cwt. of kainit may be applied in autumn, and as much more kainit, together with 3 or 4 cwt. of superphosphate in spring. When a good stock of the necessary plant-food has been accumulated in the soil the dressings need not be so liberal.

Hay and Pasture.

Seeds Hay.—Excluding sainfoin, lucerne, and pure clover, hay on tillage land is usually got from pure grass (ryegrass, timothy, cocksfoot, &c.), or from a mixture of grass and clover. The manuring of such crops must depend on the character of the plants and of the land. If clover be absent or very scarce it may be disregarded, and attention be wholly directed to stimulating the grass. In this case nitrogen in some form will be the main fertilizing element. Thus, on an ordinary loam or clay, 1 to 2 or even 3 cwt. of nitrate of soda—applied, in the case of the larger dressings, in two doses—will generally suffice, while on lighter soils sulphate of ammonia may partly replace the nitrate. In the latter case, and on peaty soil, a little superphosphate and kainit (say 2 cwt. of each) may be used. Here as elsewhere, however, the farmer should determine the matter by private experiment.

Where there is a good "take" of clover the nitrogenous dressing must be much curtailed or the clover will be smothered by the luxuriant growth of grass, and the aftermath is likely to be poor. On the other hand, phosphates and potash become of relatively greater importance. With a

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* See also Leaflet No. 160 (*The Cultivation of Lucerne*).

fair take of clover 1 cwt. of nitrate of soda, 2 cwt. of superphosphate, and 2 cwt. of kainit is likely to prove suitable; while with a strong and abundant clover plant the nitrate may be reduced by half, or even omitted, while the kainit may be nearly doubled, and the phosphates should be increased by the use of about 3 cwt. of basic slag applied early in autumn.

Meadow Hay should, if possible, get about 10—12 tons of dung per acre, applied in autumn, every four years, artificials being either omitted in these years, or, at most, consisting of about 1 cwt. of nitrate of soda applied in spring. In the intervening years 3 or 4 cwt. of basic slag in autumn, and 1 cwt. of nitrate of soda in spring, will generally pay, though in many cases the slag need only be used every second year. These quantities may be reduced if the aftermath is grazed by stock getting cake. Whether potash should be used in the years between the dressings of dung must be determined by each farmer for himself. It would appear, as a rule, to be unnecessary, though this is not always the case.

Where meadows cannot get dung the treatment should be materially different. If the land is found to respond to basic slag it should get a liberal dressing (up to half a ton per acre) in autumn, and for the next two or three years—that is to say, till the clover begins to fail—nothing more need be given. After that time attention should be given to forcing grass, as distinguished from clover, and this may be done by annually using about 1 cwt. nitrate of soda per acre. After two or three years of such treatment, that is to say, five or six years after applying the slag, the land will again be in a condition to grow clover, when a liberal dressing of slag (say 5—7 cwt. per acre) and 4 cwt. kainit should be given, followed in subsequent years by nitrate of soda as before.

If the land is not of the character that responds to slag the treatment should consist of annual dressings of a general mixture of artificials, such as 1 cwt. nitrate of soda, $2\frac{1}{2}$ cwt. superphosphate, and $2\frac{1}{2}$ cwt. of kainit. Other sources of nitrogen, phosphates, and potash may also be resorted to.

Pastures should only receive nitrogenous manure if an "early bite" for lambs or cows in spring is of great importance. In other cases phosphates—sometimes with the addition of potash—should alone be used. On land for which basic slag is suitable the treatment may be either about half a ton per acre of this substance every six or eight years, or about a quarter of a ton every three or four years. Which system will pay best can only be determined by trial, but it may be said that in the Cockle Park experiments and in similar experiments made in other parts of England the former has proved much the better. Where a heavy dressing of slag is applied every six or eight years it is an excellent plan to give cake to the stock—especially from the middle of

July—from the third or fourth year onwards. In the case of lighter dressings at shorter intervals it may pay well to use cake in the late summer and autumn of every season. If the land has a thick turf, or is in other respects unsuitable for the rapid spread of white clover, moderate dressings of superphosphate or slag (3 or 4 cwt. per acre), possibly with 2 or 3 cwt. of kainit, applied every three or four years, with the use of cake during the latter part of each season, may be recommended. On land of this description fine bone meal sometimes acts fairly well, but here, again, knowledge derived from experiment will prove the best guide. (See also Leaflet No. 168, *Formation of Permanent Pastures*.)

Applying Artificial Manures.

Of hardly less importance than the selection of manures is their distribution. Whatever the amount of manure that may be employed, care should be taken to have it spread equally over the area for which it is intended.

Good Mechanical Condition.—An important factor in the distribution of artificial fertilizers consists in fine mechanical condition, and pains should be taken to secure this. It may be necessary to pass the material through a quarter-inch riddle, breaking all the lumps that fail to go through. Some manures, *e.g.*, kainit and sulphate of ammonia, go into hard, almost rock-like masses if stored for some months, and when in this condition the expense of pulverising them is considerable. This is one reason why it is seldom desirable to store fertilizers for a long period. If this has to be done the addition of a small proportion of peat-litter dust or sawdust will make the substance more friable. The necessity of insisting on good mechanical condition is evident from the fact that one often sees artificial manure being sown containing lumps as large as peas and sometimes as large as walnuts. Not only does the presence of lumps prevent much of the crop getting its fair share of the dressing, but the spots on which the lumps fall are actually poisoned, so that the plants are weakened or killed outright. The loss from the latter cause is greatest in the case of such a crop as clover, and with highly soluble manures like nitrate of soda.

Equal Distribution.—Besides the difficulty attending the sowing of lumps, unequal distribution may be brought about by an unskilful workman, or by an attempt to put on a large dressing by a single "cast." Too often one sees the sower attempting to put on so much that directly his hand clears the edge of the sowing-sheet a considerable amount of manure falls at his feet. The effects of such work may be afterwards traced in brown and withered lines of crop running parallel across the field. Uniform distribution may be secured by the use of one of the many good manure distributors now on the market.

Patchy distribution may also have serious consequences where it is specially desirable to produce a uniform crop, as in the case of barley. The danger of loss from washing into the drains or subsoil is also greater where distribution is defective.

Artificial fertilizers should not be distributed in a high wind, especially such finely divided materials as basic slag.

The Uniform Distribution of Manures over the Farm.—Unequal distribution of another kind is met with where a farmer gives a large dressing to one field, or one part of a field, and a small dressing elsewhere. Needless to say, this is quite a rational proceeding where the land is known to vary markedly in fertility. Sometimes, however, owing to miscalculation or otherwise, one finds a farmer, for no sufficient reason, giving a liberal allowance of manure to part of his crop and a small allowance to the rest. Now, it is an incontrovertible principle in manuring that, with the exception of phosphate applied to certain types of pastures, the profits from a small or moderate application per acre of manure are relatively greater than in the case of a large dose. For instance it must pay better—other things being equal—to put 20 cwt. of nitrate of soda on to 20 acres at the rate of 1 cwt. per acre than to apply $1\frac{1}{2}$ cwt. per acre to 10 acres, and $\frac{1}{2}$ cwt. to the other ten. Or the case may be stated thus: If 1 cwt. of nitrate of soda applied to an acre can increase the oat crop by 5 bushels, 2 cwt. per acre will produce less than 10 bushels.

Thorough Incorporation of Manures with the Soil.—Where possible, manure should be thoroughly incorporated with the soil. This is of greatest importance in the case of insoluble manures, and of those, notably dung, which act to a large extent through the improvement that they effect in the physical condition of the soil. Manifestly there may be no choice but to spread the manure on the surface of the ground and to leave it there, but where it is possible to work it in this should be done. For instance, where artificials are being applied to a corn crop at the time of sowing, they should be put in with the seed, so that they may get the benefit of the subsequent harrowing.

Mixing Artificial Manures.

Finally, a word of caution may be given as regards the mixing of artificials. Probably it is now generally known that sulphate of ammonia must not be mixed with any manure holding free lime, notably basic slag and precipitated phosphate. The immediate result of making such a mixture is the liberation of free ammonia, the presence of which in the air can at once be detected by its pungent odour. If it be desired to apply sulphate of ammonia with one of these substances to any particular area of ground, the phosphate should be put on a month or more before the other substance. Sulphate of ammonia may, however, be

mixed with the other ordinary manures, such as superphosphate, dissolved bones, bone meal, kainit, sulphate and muriate of potash, and nitrate of soda.

Nitrate of soda should not be mixed with superphosphate, dissolved bones, or dissolved guano. Not only may such a mixture result in the loss of more or less nitrogen, but the mass is apt to become sticky and difficult to sow.

Superphosphate and dissolved bones should not be mixed with basic slag or precipitated phosphate, as this results in the soluble phosphate of the superphosphate or dissolved bones becoming insoluble.

Potash manures (kainit and sulphate and muriate of potash) should not be mixed for more than a few hours with any "dissolved" manure (*e.g.*, superphosphate and dissolved bones) not because anything is lost, but because the mass is apt to become smeary and unsowable.

If it should be desired to mix superphosphate and potash manures, 2–3 cwt. of bone meal or bone flour may be added per ton of superphosphate. This makes a dry mixture, but on the other hand a certain amount of reversion takes place in the soluble phosphates. Many large users of artificial manures believe the slight loss in solubility to be more than counterbalanced by the advantages obtained. It is often a great convenience to have a stock of manure prepared before the busy season sets in.

Generally speaking, however, the sooner a mixture of manures is sown after it is made the better. Some mixtures, as has been indicated, get smeary, others get lumpy, while others, like basic slag and kainit, may actually become a hard, solid, stone-like mass, which the ordinary appliances of the farmer are insufficient to break up finely.

4, Whitehall Place, London, S.W.
February, 1903.

Revised, December, 1911.

The subject of Manures is also dealt with in the following Leaflets :—

No. 18.—Fertilisers and Feeding Stuffs Regulations, 1906.
72.—Purchase of Artificial Manures.
93.—Farmyard Manure.
106.—Fertilizers for Market Garden Crops.
170.—The Uses of Lime.
175.—Waste Organic Substances as Manures.

Leaflet No. 81.

BOARD OF AGRICULTURE AND FISHERIES.

A Substitute for Dishorning.

It is well known that polled or dishorned cattle can be managed and fattened with greater facility than horned animals, and that, where a consignment consists solely of hornless cattle, the animals can be conveyed by sea or land with less danger of sustaining injury while in transit. The opinion of Irish salesmen and feeders of experience in the cattle trade, who were consulted by the Department of Agriculture and Technical Instruction for Ireland, is to the effect that Irish stores for export, when horned, require more space in railway waggons, on board ships, and in the market place; that they receive more injury in transit; and that they are worth from 10*s.* to 15*s.* per head less than hornless cattle.

The practice of dishorning cattle, by sawing off or otherwise entirely removing the horns after they are partly or fully grown, appears to inflict great pain upon the animals, and may even be the cause of death; and the Board therefore desire to call the attention of breeders and stock-owners to a method of preventing the growth of the horns by the application of caustic potash to the horn-buds of young calves. If performed in the manner set out below, and with proper regard to the precautions which follow, the operation is comparatively painless, and can be done quickly and with ease:—

Clip the hair from the top of the horn when the calf is from two to five days old. Slightly moisten the end of a stick of caustic potash with water (or moisten the top of the horn-bud) and rub the tip of each horn firmly with the potash for about a quarter of a minute, or until a slight impression has been made on the centre of the horn. The horns should be treated in this way from two to four times at intervals of five minutes. If, during the interval of five minutes after one or more applications, a little blood appears in the centre of the horn it will then only be necessary to give another very slight rubbing with the potash.

The following directions should be carefully observed :—

1.—The operation is best performed when the calf is under five days old, and should not be attempted after the ninth day.

2.—Caustic potash can be obtained from any chemist in the form of a white stick. When not in use, it should be kept in a stoppered glass bottle in a dry place, as it rapidly deteriorates when exposed to the air.

3.—One man should hold the calf while an assistant uses the caustic.

4.—A piece of tinfoil or brown paper should be rolled round the end of the stick of caustic potash which is held by the fingers, so as not to injure the hand of the operator.

5.—The stick should not be moistened too much, or the caustic may spread to the skin around the horn and destroy the flesh. For the same reason, the calf should be kept from getting wet for some days after the operation.

6.—Care should be taken to rub on the centre of the horn, and not round the side of it.

Note.—Caustic potash is *poisonous*, and must therefore be kept in a safe place.

4, Whitehall Place, London, S.W.,
February, 1903.

Revised, April, 1908.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 82.

BOARD OF AGRICULTURE AND FISHERIES.

Preparation of Wool for Market.

In view of the great competition in the trade in wool, it is important that flock-masters and others should pay great attention to the conditions under which wool is produced, and to the cleanliness and packing of fleeces before sending them to market. The following suggestions bearing on these points have been drawn up in consultation with the Bradford Chamber of Commerce.

Washing and Shearing of Sheep.

In districts where tub-washing is not adopted, the sheep should be washed without any artificial assistance, that is to say, in cold water without any soap except the natural soap which exudes from the skin in sufficient quantity at the shearing period.

The sheep should not be allowed to run too long after washing before being sheared, as this practically brings the wool back into greasy condition. Nor should they be clipped or the fleeces wound while wet, as this takes away the "liveliness" from the fibre and causes the wool to rot.

The shearing should not be performed in dirty places, such as barns littered with chaff and straw and other matters, which get into the wool and cause much trouble and annoyance. The cost of this fault to the dealer and manufacturer is far more serious than flock-masters think, as it is often impossible to get this foreign matter out without the use of chemicals, which further spoil the wool.

When the fleece is wound, no earth or dung should be left on, or be allowed to get in whilst winding. No locks, tailings, skin wool, black or cots should be wrapped up inside fleeces, neither should greasy wool be wrapped up inside washed fleeces.

Tar-Branding of Sheep.

Where it can be avoided, tar should not be used for marking sheep. A large quantity of wool used for manufacturing purposes does not undergo the process of sorting, and thus it frequently happens that, in spite of efforts to remove tar-marks, some of the tar passes into the finished goods, thereby causing considerable damage and loss. Even when the wool is being sorted it is very difficult to entirely eliminate the tar.

As tar is not dissolved in the ordinary processes of wool-washing, flock-masters should endeavour in cases where its use cannot be avoided to improve the methods of applying it, either by making use of smaller marks or by adopting means to prevent the tar from running. If practicable, marking on the ear or face is much to be preferred.

Methods of Tying Fleeces.

The fleeces should be rolled on a clean wooden table, and should be tied up with bands made by twisting a portion of the fleece itself. It is not necessary for these bands to be tightly twisted, the object being merely to keep one fleece separate from another. String composed of vegetable matter, such as hemp, jute, &c., is bad, and ought not to be used. The most careful manipulation by the manufacturer often fails to detect some small pieces of string, which do not make their appearance until the cloth is dyed, because vegetable matter absolutely refuses to take the dyes used for wool. Dress goods and cloths are often damaged in this way to a very considerable extent. Most farmers tie up their fleeces with wool bands, and have done so for generations, except in a few western and southern counties. In the latter the use of string (and frequently the worst kind of string, such as reaper or binder twine) is not uncommon. This use of string is unprofitable to all the parties concerned. The amount of damage done is a very serious matter to the manufacturer, and the district from which such wool comes suffers in reputation.

Dips.

In the selection of dips, care should be taken to use only those that do not permanently stain the wool, and dipping should not take place for some months before shearing.

The results of experiments arranged by the Departmental Committee, appointed by the Board of Agriculture and Fisheries in April, 1903, to investigate and report upon the dipping and treatment of Sheep, go to show that tar acid (carbolic), tobacco and arsenical, with or without sulphur, dips, when skilfully prepared, leave the wool in a nice condition. Fleeces so treated were placed in the first class by the Bradford Conditioning House, as not having deteriorated in value as a result of the dip. Pitch oil, spirits of tar, and crude tar products lowered the commercial value of the fleece by 5 or 10 per cent.

4, Whitehall Place, London, S.W.
April, 1903.

Revised, September, 1904.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Preservation of Eggs.

The supply of eggs upon our markets is very irregular. During the spring and early summer months eggs are plentiful, both as regards home production and foreign imports. As a consequence prices fall considerably. In the autumn and winter, however, new-laid eggs are scarce and realise high prices, whilst the returns for even the cheaper grades of foreign eggs, most of which are preserved, or "pickled," are considerably above the spring rates. Hence an egg produced in November will command twice, and sometimes thrice, as much as it would in the month of April.

One advantage in preserving eggs is that the withdrawal of surplus supplies in the cheap season tends to the steadying of the prices obtained by producers. If eggs were a non-perishable product, and could be kept in prime condition from one season to another, wide variations in supplies would be avoided, and the extremes of prices prevented. This is to some extent met by the process of preservation, and when the natural deterioration is retarded or stopped in this way, eggs can be sold, if in good condition, at rates which leave a sufficient margin of profit. Simple means of preservation are also extremely useful as a means of regulating the domestic supply.

The following are the methods which, up to the present, have yielded the best results :—

Lime Water.

An egg pickle, composed of lime, salt, cream of tartar, and water, was patented upwards of a hundred years ago, and a modification of this preparation is still used extensively both at home and abroad. The pickle as now generally employed is made by mixing four parts by measure of finely slaked lime with twenty parts of cold water, and afterwards adding one part of salt. This solution should be prepared by mixing the lime and the water a week before it is to be used, and stirring well together daily, adding the salt on the fourth or fifth day. The eggs should be placed in vats, barrels, or crocks, and the cleared solution poured over them, care being taken to avoid adding any of the lime sediment, otherwise there is danger of the solution becoming a solid

mass. Where large quantities are preserved they should be placed in cement tanks, each holding 60,000 to 80,000, this being a more economical arrangement. It is desirable not to fill the vessel with eggs, but to allow two or three inches of solution above the top layer. A little fresh solution should be added occasionally, in order to provide for evaporation. An egg preserved by this method can be easily recognised by the roughness of the shell. When the egg is boiled the shell will crack, a result due to the effect of the lime upon the outer covering, causing it to be hard and brittle. This may generally be prevented by pricking the broad end with a needle when the egg is about to be boiled, though preserved eggs are not recommended for boiling.

Waterglass.

Waterglass is the name given to a solution of silicate of soda, and is prepared by dissolving the chemical in water. It can be obtained from chemists, and is now largely sold in the form of a concentrated solution, to which should be added five or ten times its bulk of pure boiling water, according to the strength. The preparation should be quite cold before it is used. Experiments in America have shown that a 3 per cent. solution (*i.e.*, 3 parts by measure of waterglass to 97 parts of water) yields as good results as that generally recommended, namely 10 per cent. A 5 per cent. solution may be used with safety, and with this strength there is less danger of giving the eggs an objectionable flavour than with the stronger solution. When the waterglass is added to the water the two must be very carefully and thoroughly mixed. The eggs may be dipped in the waterglass and dried off, leaving a film on the shell, and then stored upon shelves, or they may be kept in the liquid until sold or used. The latter method is to be preferred. When taken out of the solution they are sticky, and before packing should be washed and dried.

It has been shown* that the changes in eggs preserved in waterglass take place very gradually; at one year old they are hardly noticeable, at two years they are distinct, but not so distinct as at three or four years old. Eggs which had been preserved for about six months tasted and smelt like well-kept eggs a few days old, but as the eggs in question were a few days old when placed in the waterglass, it did not seem that they were appreciably changed. At three or four years old the white became pink in colour and very liquid, but even at four years old the eggs had no unpleasant taste or smell, and the white coagulated in the usual manner in cooking. Practically no change was observed in the composition of the eggs, even after lengthened immersion.

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* Hendrick, *Journal of Agricultural Science*, January, 1907

Cold Storage.

The methods already described are equally suitable for large and small quantities, and may be adopted either by the farmer or by the trader. Cold storage, on the other hand, in order to be profitable, must be done upon a large scale, and is consequently not available for small producers unless they have a cold storage plant for other purposes. In America this system is extensively employed, and large plants have been specially erected for the business. Eggs require to be unpacked and laid upon shelves or in trays, and kept at an even temperature, not falling below 33 degrees Fahrenheit, with a free circulation of air, which air should be absolutely sweet. No other products should be kept in the same room, otherwise the eggs may be affected. By this method, provided that the eggs are new laid when placed in storage, they can be kept for many months in good condition, but great care is necessary in removing them for use, as a too sudden change of temperature causes rapid deterioration. In all cases they require to be used very speedily on removal from the cool chamber, and the evidence obtained in this and other countries shows that cold storage eggs will keep for a much shorter period after they are taken out of the chamber, than if preserved in solutions of lime or of waterglass as described above.

Other Methods.

For domestic purposes, and for a shorter period than is usual commercially, eggs may be thinly coated with butter or glycerine, within a few hours after they are laid, as soon as they have cooled down. It is necessary to see that the shell is entirely covered to close the pores. In the case of glycerine dipping is preferable. The eggs should be stored in a cool place and stood upright on perforated shelves or wired trays. If turned twice a week keeping will be improved. It is important that the atmosphere be pure, and that there be no strong-smelling products near, otherwise the eggs may be affected.

General Suggestions.

1.—Eggs for preservation should be treated as soon as possible after they are laid, but not until they have been cooled. An egg twenty-four hours old is superior to one a week old; consequently, if the egg is not absolutely fresh when placed in the preserving medium the final result cannot be entirely satisfactory. It is therefore desirable that preservation should take place as soon after production as possible.

2.—Eggs should not be treated in a warm place, and where limewater or waterglass is used the preparation should be quite cold before the eggs are placed in the solution.

3.—Eggs from hens fed chiefly upon grain, and with full liberty, are likely to keep better than those laid by fowls in confined runs.

4.—The general experience has been that infertile eggs keep in good condition longer than those which contain a living germ. Probably this is less apparent when eggs are preserved at a low temperature.

5.—When eggs are preserved in waterglass or limewater the vessels containing them should be stored in a cool place, at a temperature of not less than 33 degrees Fahrenheit, nor more than 45 degrees. A cool, well-ventilated cellar is excellent for this purpose. Exposure to a higher temperature, even for a few hours, will cause deterioration in spite of the preservative.

6.—Eggs may be stored in large or small quantities, and may be allowed to remain in the pickle for six months. Wooden, cement, or galvanized iron vessels should be employed.

7.—Eggs should be carefully tested before they are preserved, and again prior to sale. For this purpose a well-constructed candling lamp is to be preferred; but a piece of black cardboard, 8 inches square, with an oval hole in the centre rather smaller than an ordinary egg, can be used. Each egg should be placed against the hole, and held between a strong light and the eye, so that the condition of the contents can be observed. In the final test all dark eggs or those showing spots or black shadows should be rejected.

8.—The best months for preserving are March, April, May, and June. It has been found in many cases that summer eggs do not keep nearly so well as those laid before the hot weather.

9.—Preserved eggs should be sold under that name, and not as "new-laids," "breakfast," or "fresh" eggs.

4, Whitehall Place, London, S.W.,
March, 1903.

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Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 16 leaflets dealing with Poultry and Bees, their Breeding and Management, may be obtained from the same address, price 1d. post free.

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Leaflet No. 84.

BOARD OF AGRICULTURE AND FISHERIES.

The House-Sparrow (*Passer domesticus*, L.).

The house-sparrow is so well known that a detailed description of it is unnecessary. In almost all parts of Europe where grain is grown this bird is, unfortunately, far too common. It has been introduced into New Zealand, Australia, and North America, and has in these countries, as in Great Britain, increased to such an extent that it has become a serious pest to the farmer and gardener alike.

To practical farmers the case for the reduction of the sparrow to smaller numbers rests upon an estimate of the damage done, compared with the useful work carried on by the bird. It may be taken for granted that no one wishes to exterminate the sparrow, but it is the opinion of all who have paid any attention to the subject, that the limits of the sparrow's usefulness have long ago been overstepped, and that its reduction to more reasonable numbers is as necessary in the interests of the community at large as the reduction in the number of rats, or of any other destructive beasts, birds, or insects.

Food Habits.

Hundreds of examinations of the contents of the stomachs of sparrows have been made in this country and abroad, and it has been shown that from 75 to 80 per cent. of the food of adult birds throughout the whole year consists of cultivated grain of some sort. A farmer in the neighbourhood of a town or village where the bird has been unmolested has this fact forcibly brought home to him in much diminished crops. In such districts, the profitable cultivation of cereals becomes well-nigh impossible.

The sparrow does most damage during the few weeks before harvest. Thousands of adult birds and the young birds of the season feed upon the ripening grain and live almost entirely in the fields, deserting the village and farm homesteads for a time. Later they live mainly round human habitations, taking grain from the stacks and poultry yards.

The destructive practices of sparrows are not confined to grain crops. They are almost equally damaging to garden produce, apparently taking a delight, in winter and spring, in stripping gooseberry and red currant bushes of their buds; tearing in pieces various brightly coloured flowers, such as

crocuses, primroses, and violets; destroying the blossoms and young fruits of the gooseberry; eating the young shoots of carnations in winter; and pulling up rows of newly-sown peas in spring and summer.

Ricks and thatch are damaged by them, and rain-water pipes are frequently blocked by their nests.

It may reasonably be asked if nothing can be said in favour of the sparrow. Examination of young birds in the nest, and those recently fledged, has shown that they feed partially upon caterpillars, beetles, crane-flies, aphides, and other insects. The amount of their food consisting of insects is, however, not more than 50 or 60 per cent., and then only for a short period of their early life. The extent of their usefulness in this respect is thus not sufficient justification for maintaining the vast numbers which are met with throughout the country. It must also be remembered that the sparrow drives away swallows, house-martins, many warblers, and other purely insect-feeding birds, which would do most of the useful work carried on by the sparrow if they were undisturbed.

Nesting Habits.

The nest of the house-sparrow is placed in all sorts of situations: exposed in trees and shrubs, in holes in hayricks, thatch, walls and trees, in rain-water pipes, under the eaves of houses, in ivy-clad walls, and in the nests of the house-martin and swallow. It is rarely found more than a mile or so from human dwellings, and is usually made of straw, hay, or dried grasses, more or less in the form of an oval ball with an opening into it at the side. Five or six eggs are laid, of a bluish-white ground colour, blotched or speckled with brownish or blackish markings which vary very considerably.

Each pair of birds may rear two or three broods during the summer, and this accounts for the rapidity of increase when unmolested in districts where food is plentiful.

Methods for reducing the Number of Sparrows.

Any attempt to reduce this, or any other living pest capable of rapid reproduction, must be thorough and must embrace the whole of the district infested. It is of little use to kill the sparrows in one locality, if they are allowed to multiply in surrounding parishes. Not only should sparrows be destroyed round villages and hamlets, but attention to every isolated farmyard in the neighbourhood is essential. Sparrows left to multiply on one or two farms in a district soon spread over the neighbouring areas. The particular methods for lessening the number of sparrows are very numerous.

a.—Eggs and nests may be destroyed in the breeding season.

b.—Various forms of nets may be employed on dark nights, around ricks or ivy-clad houses where the birds roost.

c.—Shooting with small shot during winter is useful.

In all cases great care must be exercised to prevent other birds suffering along with sparrows.

d.—As individual private effort can have but a slight effect, the work of lessening the sparrow plague in a district is best carried out by the formation of a Sparrow Club such as is described below.

Sparrow Clubs.

The object to be attained by a Sparrow Club should be made clearly known to all who join it. Anything like indiscriminate destruction of small birds in general should be strenuously avoided, the object being merely to reduce the numbers of the house-sparrow. Every encouragement should be given to the protection of all other small birds, unless there are obvious reasons for including other species than the sparrow in the black list.

Very frequently it is found that rats can be dealt with at the same time as sparrows.

The following may be taken as a scheme of rules, which can be amended or curtailed according to the requirements of the district :—

Rule 1. The name of the club shall be "The............and District Sparrow [and Rat] Club," and includes the parishes of......................

Rule 2. The club shall consist of subscribers or honorary members and working members. The annual subscription of an honorary member shall be not less than 5*s.* [or 2*s.* 6*d.*], that of a working member 1*s.* Honorary members shall be exempt from bringing heads.

Rule 3. House-sparrows and rats only to be decreased. Each sparrow shall count one point, each rat two points.

Rule 4. Each working member shall send in during the year birds or rats representing not less than 300 points before he is entitled to share in the division of the prize funds.

Rule 5. No birds or rats shall count unless they are taken in the parishes mentioned in Rule 1. Any member infringing this rule shall be fined 5*s.*

Rule 6. Members found smoking in stackyards or on any premises whilst catching sparrows or rats or loading shot-guns with ordinary paper instead of stout wads, shall be disqualified for all prizes.

Rule 7. The balance at the end of the season shall be divided among the working members according to the total number of points obtained during the year.

Rule 8. Collectors shall be appointed in various parts of the district to receive and destroy heads of birds [and tails

of rats] once a week, at a time fixed to meet the convenience of the working members.

Rule 9. An annual meeting shall be held at..............in May or June, at which the accounts shall be audited, the funds divided in accordance with Rule 7, officers appointed for the succeeding season, and any other business connected with the club transacted.

A club in Kent, worked along the lines indicated above, with less than twenty working members, destroyed during three seasons over 28,000 sparrows and more than 16,000 rats in a comparatively small area with obviously useful effect. The annual prize-money amounted to a little over £6 per annum.

If such clubs could be instituted and their work carried out systematically for three or four seasons throughout the country, there would be a great improvement in increased crops on farms and gardens, while martins and other insect-feeding species of birds would have a better chance to increase.

The Hedge-Sparrow.

It may perhaps be advisable to note that the hedge-sparrow (*Accentor modularis*, L.) is in no way related to the house-sparrow, the former being a very useful bird, which needs protection, since its diet consists almost entirely of insects. It has a soft narrow beak quite unlike that of the house-sparrow, which is hard and specially adapted for eating seeds. The nest of the hedge-sparrow also, is quite different from that of the house-sparrow, being open, and composed of plants, roots, and moss, lined with hair or wool, while the eggs are blue in colour.

The Tree-Sparrow.

The only bird likely to be mistaken for the house-sparrow is its near relative the tree-sparrow (*Passer montanus*, L.). The latter is a much rarer and more locally distributed species, somewhat smaller in size, with two white bars across its wings instead of one as in the house-sparrow. The male house-sparrow has a white patch on its cheek or side of its head; in the tree-sparrow the white cheek has a black triangular patch on it. The tree-sparrow is of small economic importance compared with the other.

4, Whitehall Place, London, S.W.
April, 1903.
Revised, May, 1908.

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Leaflet No. 85.

BOARD OF AGRICULTURE AND FISHERIES.

Haymaking.

The details of this operation vary considerably in different parts of the country. In the North and West of England, and in Scotland, the rainfall is heavier, and the air more humid, than in the South and East, with the result that in our drier districts hay can be brought into a condition to carry with an amount of labour that would be quite insufficient under other circumstances. The crops too, in the drier districts are usually comparatively light, so that they dry with little handling. The details of haymaking are also influenced by the character of the crop—whether from old meadows, or new leys; whether holding much or little clover &c. The details of the process will also vary with the area to be dealt with, a large extent of land demanding the use of machines that would be quite out of place on a few acres of hay land.

In general, however, the principles of haymaking are the same. The objects are to cut the crop at the time when quality and quantity of yield are about their maximum, to handle it with the least expenditure of labour, and to "save" it with the smallest loss of nutritive properties.

Time to Cut.

The best time to cut is when the bulk of the grasses are in flower, that is to say, when the anthers or pollen sacs are protruding from between the chaff scales. At this time the weight of herbage is nearly at its maximum, while the nutritive and digestive properties are at their best. From this point onwards the stems become hard and indigestible, and the riper the seeds the greater is the waste during the subsequent processes of haymaking.

Before the seed is ripe most of the nutritive materials are distributed throughout the leaves and stalks, but whenever the seeds begin to form they attract these materials from the rest of the plant, so that if the seeds are subsequently

knocked out of the hay the loss of nutritive substances is quite out of proportion to the loss of weight.

If the ley be a new one, and the grass chiefly consists of a single species, say ryegrass, the time to cut is not difficult to determine. But on old grass-land, carrying a great variety of plants, some species may be dead ripe before others have come into flower. Meadow Foxtail, Sweet Scented Vernal, Cocksfoot, and the Rough and Smooth stalked Meadow Grasses may be ripe, and have shed much of their seed, before such a grass as Timothy has come into flower. It is therefore impossible to catch all plants exactly at the right time, but at least a farmer should start his hay harvest on a field where early grasses are most abundant, or where, owing to thin soil or a south exposure, maturity is most advanced. Then, again, there are some plants, like Cocksfoot, which become hard and unpalatable sooner than others, and, where these predominate, cutting may take place before the flower heads are well out of the sheath.

A little loss in weight owing to making an early start is usually more than counterbalanced by the superior feeding properties of the crop, and by the greater quantity and quality of the aftermath. If a second crop of hay is contemplated, the advantages of starting early with the cutting of the first crop are specially emphasised.

Manner of Cutting.

In the case of meadow hay the crop can hardly be cut too close to the ground, but with rotation hay it is found that red clover produces more aftermath if the first crop has not been cut too close, and, especially so, if very sunny weather occurs when the crown of the root has recently been exposed. It is contended that red clover is most permanent, and the aftermath is better, when the crop is cut by the scythe than where the mowing machine is employed. This result has been ascribed to the cut surface made by the scythe being somewhat oblique and so running off the rain, whereas the cut of the machine is perfectly horizontal allowing the rain to enter and to rot the root, but it is probable that the greater length of the stubble generally left by the scythe is the true cause.

"Making" the Hay.

It hardly need be pointed out that the weather is here the determining factor, but as a general principle it may be said

that the less hay is turned and knocked about the better. Every time it is moved it suffers loss through the shedding of seed, and the separation of the fine leaves, and especially clover leaves. These two portions, the seed and fine leaves, are the most valuable part of the crop, and every effort should be made to preserve them. Then, again, the more hay is moved the more are the stems and leaves of the plants bruised and broken, and should rain subsequently intervene a relatively large amount of nutritive matter will be washed out of the crop.

Every farmer strives to get his hay beyond the washing influence of rain as soon as possible. Rain water may dissolve and remove more than ten per cent. of the dry matter of hay, and what is thus removed may represent quite twenty per cent. of the feeding value.

In the drier districts of England hay is generally raked into windrows straight from the swathe, and put directly into the stack, but in other districts it has to be turned, cocked, and often piked, or put into field "tramp-ricks" before being fit to stack. If the weather admits of the crop being stacked or ricked straight from the swathe the minimum of loss will occur, combined with greatest economy of labour; but if this cannot be done, and if wet weather threatens, it is a great advantage to put the crop, even if not in first rate condition, into small cocks, which, when the weather is dry, may be shaken up, and afterwards carted. Half an inch of rain means some 50 tons of water per acre, and if the crop be equally spread over the ground it is, of course, subjected to the whole of the washing influence of this quantity of water. But if the crop be put into cocks that occupy only one-tenth of the area it follows that the hay will be affected by only one-tenth of the rainfall, that is to say by 5 instead of 50 tons of water.

Not only does water actually wash out much of the soluble and most valuable of the constituents of hay, but it also removes the aroma, and leaves the crop much less appetising as food for stock. The colour, too, suffers, and with it the selling value.

In the stack the hay should be consolidated as thoroughly as possible, and this is secured by spreading it evenly, and by careful trampling. The object is to exclude air as much as possible, and so to keep fermentation within proper bounds. If this is secured, the produce will be of a good colour; green, in the north and west, where the natural sap is largely eliminated by handling in the field, and brown, in the south, where the sap is more conserved. If the crop is loosely stacked, air enters too freely, excessive fermentation takes place, and the resulting produce, being partially carbonised, will be very dark in colour and of low value. A light crop, or a crop consisting of fine grasses, packs more

easily in the stack, and requires less trampling, than a strong "stemmy" crop into which air enters more freely.

For details of haymaking on a large scale, by the use of labour-saving machinery, reference may be made to an article by Mr. Primrose McConnell in the first number of Vol. IX of the Board's Journal.

4, Whitehall Place, London, S.W.,
May, 1903.

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BOARD OF AGRICULTURE AND FISHERIES.

Brown Rot of Fruit.

(*Sclerotinia fructigena*, Nort.).

This is undoubtedly one of the most general, and also the most destructive of diseases against which the fruit grower has to contend. It attacks apples, pears, plums, cherries, peaches, and is also not uncommon on various wild fruits belonging to the order *Rosaceæ*, as bullace, crab, &c.

To the ordinary observer this disease first attracts attention when it appears on the fruit under the form of brownish scattered patches on the skin. This is followed by the growth of dull grey tufts (the so-called *Monilia* fungus), which are usually arranged in irregular concentric rings. These grey tufts are composed of dense masses of spores arranged in long branched chains.

The fairy-ring arrangement of the fungus is most evident on apples and pears; on plums, cherries, and stone fruit generally, the grey tufts are irregularly scattered over the surface.

Although most obvious on the fruit, the fungus usually first attacks the leaves, where it forms thin, velvety, olive-green patches. The spores from diseased leaves are washed by rain, or carried by insects, on to the surface of the young fruit, or not infrequently the flowers are also inoculated from spores derived from young leaves; and in many instances where brown and shrivelled blossoms are attributed to the action of a late frost, the true cause is in reality due to the *Monilia* fungus.

In those instances where the disease has been allowed to follow its course undisturbed for some years, the young shoots of the trees are also attacked and killed during the first or second year. The fungus develops rapidly on such dead twigs, and furnishes a ready supply of spores, which are mature during April and May, just when the young leaves and blossom are most susceptible, and wholesale infection results.

Fruit attacked by this disease does not rot and decay, but becomes dry and mummified. Such fruit often remains hanging on the tree until the following season. Whether it does so or falls to the ground, it is practically unchanged until the following spring, when its entire surface becomes covered with a copious crop of spores, which are dispersed by various agencies, and the disease repeats itself.

It has long been suspected that the *Monilia* represented but one stage in the life-cycle of the fungus; this supposition has proved to be correct, the second or ascigerous form of fruit having been found growing abundantly on old half-buried peaches in several orchards in different parts of the United States, where the fungus proves quite as destructive as with us.

Preventive Measures.

All dead twigs and shrivelled fruit, whether hanging on the tree or lying on the ground, should be collected and burned during the winter.

After the diseased fruit and dead branches have been removed, the trees and also the ground should be thoroughly drenched with a solution of sulphate of iron, prepared as follows:—

Sulphate of iron...	25 pounds.
Sulphuric acid	1 pint.
Water	50 gallons.

Pour the sulphuric acid upon the sulphate of iron, then add the 50 gallons of water by degrees. A barrel is the best vessel to use; a metal vessel must not be used, as it would be acted upon by the sulphuric acid.

Spraying with the above solution should be done in January or February, before the leaf-buds begin to swell in the least, otherwise the foliage and blossom will be destroyed.

When the leaf-buds are expanding, and at intervals as required, the trees should be sprayed with quite weak Bordeaux mixture.

The above line of treatment must be followed for at least two seasons.


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Explanation of the Figures.

1. A diseased shoot with the persistent blossom of the previous year; cut from the tree in February. Both twig and flower-stalks bear tufts of the fungus. Nat. size.

2. Cherry leaf attacked by the fungus. Nat. size.

3. An apple recently attacked, and showing the fungus growing in concentric rings. Nat. size.

4. Fresh cherry blossom attacked by the fungus. Nat. size.

4, Whitehall Place, London, S.W.
May, 1903.

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Leaflet No. 87.

BOARD OF AGRICULTURE AND FISHERIES.

A Fungus Disease of Young Fruit Trees.

(*Eutypella prunastri*, Sacc.).

Every now and again this minute but very destructive parasite appears under the form of a disease wave, causing a very considerable amount of damage, hundreds, or in some instances thousands, of young trees being injured or completely killed during one of these sporadic attacks.

Young standard fruit trees, up to the age of eight years, are most liable to the disease, and as the stem or stock is the part attacked, the girdling of this portion of the plant by the fungus growing in the bark and cambium means the death of the entire tree, which in a dull and damp season favourable to the rapid growth of the parasite, usually occurs during the spring following the first year of attack.

In the case of nursery stock, plum (especially the variety called Victoria) and apple trees have suffered most severely in this country ; peach, apricot, and cherry to a less extent. The fungus is also often very abundant on wild plum, bullace, blackthorn, &c., and it is the spores produced on such wild trees that infect cultivated stock.

The first indication of the presence of the disease is the premature yellowing and fall of the leaves, followed by a drying up, browning, and shrivelling of the bark of the stem. During the spring following the first year's inoculation, numerous minute, elongated cracks, arranged in dense clusters, appear in the dried-up bark. These represent the first form of fruit produced by the fungus (Fig. 1), and are followed during the second season after infection by larger, fewer, and more irregularly scattered cracks, always transversely arranged in the now dead bark, containing a second and more highly developed kind (ascigerous) of fungus fruit (Fig. 3).

The spores of the fungus are mature during late spring and early summer, and it is at this season that infection of

young fruit trees takes place, the spores gaining access to the stem either through the unprotected ends of pruned twigs or through the living bark itself.

All wounds on the stem exposed by cutting off shoots, *however small*, should be protected *at once* by a coating of gas-tar, until the tree is at least ten years old. If this precaution is neglected, spores frequently alight on the newly-formed wounds, where they quickly germinate and spread upward and downward in the living bark, which becomes discoloured; finally the fungus bursts through the bark it has killed, and produces spores on the surface (Fig. 6).

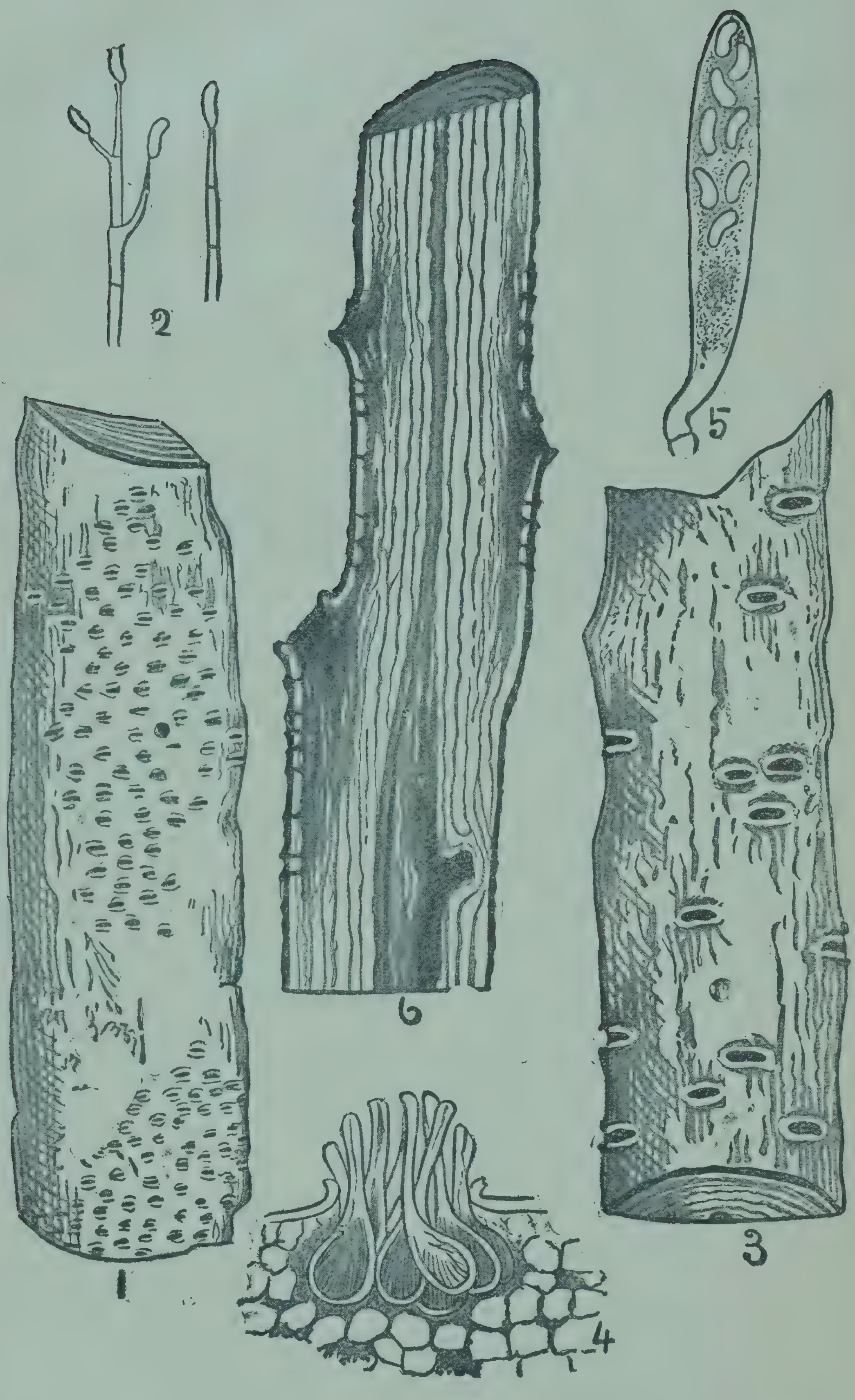
In order to prevent spores from germinating on the surface of the stem, and then entering through the bark directly, the entire stem of the tree should be painted with the following composition:—Reduce soft-soap to the consistency of thick paint by the addition of a strong solution of washing soda in water. Add one pound of powdered quick-lime to every five gallons of the dissolved soap, and stir the whole until thoroughly mixed. Apply to the trunk with a paint brush, being careful to cover every part. This mixture is tenacious, not easily dissolved by rain, and usually lasts for one season if properly made and applied.

Up to the present the disease has only been observed on a large scale where the trees are growing in stiff clay. Under such conditions it is very important to avoid deep planting, otherwise the roots are liable to be killed, owing to the presence of stagnant water, lack of air, &c., during a continuous rainy period, especially in spring or early summer. If the trees are not actually killed by this means alone, which is very frequently the case, their vitality is considerably weakened, and they are thus rendered more susceptible to the attacks of parasitic fungi.

In a case of an extensive attack which the Board investigated in the county of Nottingham in 1902, the trees had evidently been seriously crippled by being planted too deeply in a strong soil, and were consequently specially susceptible to attack.

It is important that the fungus should be recognised by gardeners, as its frequent occurrence on wild trees in hedgerows might lead to the infection of nursery stock in a wholesale manner, as has in fact taken place, more than once, unless detected and removed without delay.

All diseased plants should be burned at once, as, if allowed to lie about, the spores mature on the dead wood, and are scattered by wind, a risk of further infection being thereby incurred.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Description of Figures.

1. *Eutypella prunastri;* spore-bearing form of reproduction on an apple tree stem. Nat. size.

2. Spores. × 600.

3. Second, or ascigerous, condition of fungus-fruit on plum stem. Nat. size.

4. Section through a group of ascigerous fungus-fruits embedded in the bark. × 50.

5. Ascus containing 8 ascospores. × 400.

6. Median section through portion of the stem of a young apple tree, showing where the fungus had entered through the unprotected ends of pruned shoots. The mycelium of the fungus had discoloured the bark and wood, and finally burst through the bark to the surface. Nat. size.

4, Whitehall Place, London, S.W.
May, 1903.

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Leaflet No. 88.

BOARD OF AGRICULTURE AND FISHERIES.

Hop Aphis (*Phorodon humuli*, Schrank.).

The chief insect pest with which the hop grower has to contend is the Hop Aphis (*Phorodon humuli*, Schrank.), also known as the Hop "Fly" or "Louse." In former years, before the introduction of washing to combat this pest, the hop crop was often almost entirely destroyed by its attacks; and hops rose to famine prices. A general "black blight" occurred in 1882, since which year washing has been universal among the good growers of hops, but the years 1901, 1902, 1903, saw attacks which seriously affected the crop in quality or in yield, and again in 1904 and 1906 the harm done by the insect was very great. The first symptoms of an attack are usually to be seen early in June; here and there among the hops will be found a stout winged green aphis, and on the underside of the unfolding leaves near the tops of the shoots minute wingless "lice" may be detected, the soft growing points of the plant being always the parts first attacked. If the weather conditions are favourable and nothing is done to check the attack the aphides multiply with inconceivable rapidity; in a week or two the undersides of all the leaves become dotted over with wingless lice of all sizes, while the sticky exudations from the insects coat the leaves below and give them a dark shiny appearance. Finally, this "honeydew" turns black, the growing shoots shrivel and curl, and the development of the whole plant ceases. Sometimes after such a "black blight" the plant clears itself later in the season, and should heavy rain wash the leaves, it will put forth a little new growth on which a few hops will be carried. Should the conditions be less favourable for the rapid multiplication of the aphides, lice may be found on the plant during the whole season, and will then harbour in the cones of the hops; as they die there the remains turn black owing to the invasion of a fungus, and the hops, after picking and drying, will be found with black cores, their value being much depreciated.

Description and Life History.

The hop aphis belongs to the large family of plant lice which includes many of the most characteristic pests of the farm and garden, such as the well known "green fly" of the

rose, the black "collier" which infests the top of broad beans, the black cherry louse, the reddish lice of apples, plums, and currants, the aphis of corn, and of the turnip, &c.

The mature form of the hop aphis is about one-eighth of an inch long, with a plump body and three pairs of legs ; the mouth is prolonged into a proboscis adapted for piercing the leaves of the plant and sucking the sap upon which the insects live ; towards the extremity of the abdomen are two tubes from which exudes the sticky "honeydew." Two pairs of transparent wings may or may not be present, for both winged and wingless female forms occur, the former being generally distinguished as "fly" from the wingless "lice" ; there is also a winged male.

Two cycles of life history are known, one complete on the hop, the other involving a migration from the sloe, damson or plum back to the hop again. This latter cycle is the most important.

In the first cycle the wingless female form hibernates in the ground and crawls on to the hop plant in the spring, when she immediately begins to deposit living young upon the soft leaves. These young in their turn begin to reproduce themselves without the intervention of a male for many generations, multiplying with astonishing rapidity. Some of these lice enter the pupal state, from which they emerge as winged females and fly to other hop plants, where they again reproduce themselves asexually. Finally, towards the autumn most of the lice turn into pupae, and emerge as winged females and males, which copulate before leaving the hop. Some of the wingless females go to ground before winter and hibernate until they can resume their asexual reproduction on the young hop in the spring.

In the second cycle the winged female after fertilisation by the male in autumn leaves the hop and flies to the sloes, damsons or plums, where she deposits eggs near the tips of the shoots and in the forks of the twigs. In the spring these eggs hatch into lice, which in May or early June develop wings ; the winged females then fly back to the hop, where they reproduce living lice as before described for ten or twelve generations before fresh winged forms are developed. Migration may continue on through the summer. It is the enormous rapidity with which the wingless forms reproduce themselves that constitutes the danger of an attack of the hop aphis ; the whole plant may become completely smothered in lice if neglected for a week or two.

Natural Enemies.

The lady-birds, both in their adult and larval forms (when they are known in the hop gardens as "niggers") are great devourers of aphides and are sometimes numerous enough to keep a mild attack in check.

The lace-wing fly, which lays its white eggs in little groups, each supported on a long stalk, on the underside of the leaves of the hop and other plants, devours great numbers of aphides when in the larval stage.

Several species of chalcid fly are parasitic upon aphides; they lay their eggs in the living aphis, the interior of which is devoured by the larvae.

Treatment.

1.—The only way of dealing with the hop aphis is to spray or "wash" the hops with a mixture containing soft soap as a basis. As the aphis secretes something of a sticky or waxy nature it is not readily wetted by pure water; the presence of the soft soap causes the wash to touch the aphis, and as it dries the thin layer of soft soap clogs the breathing pores and kills the insect. A few growers use soft soap alone, but the majority add a decoction of quassia chips, the bitter principle of which is either directly poisonous to the aphis or renders the leaves distasteful to those which escape.

The soft soap should be carefully selected, it should be newly made and from such kinds of oil as do not yield hard flocks of curd when the soap is mixed with hard water. It is desirable to test beforehand the lathering powers and the character of the curd that is formed by dissolving one-fifth of an ounce of the soap in question in half-a-gallon of water, shaking well and observing the stability of the lather and whether any curd separates on standing. The amount of soap to be employed varies with the hardness of the water; with soft water four pounds per 100 gallons will be sufficient, while hard waters often require eight or ten. Large quantities of soft soap will scorch tender foliage, hence when the water is hard it is advisable to have an analysis made, as it is often possible to reduce the hardness by adding a little carbonate of soda.

6lb. of good quassia chips should be simmered for two hours with just enough water to keep the mass liquid. The decoction may then be strained off and the soft soap stirred in till it dissolves, a process which may be assisted by further boiling. This stock mixture should be diluted down as required with cold water to 100 gallons.

Many forms of spraying machines are used for distributing the wash. For small gardens a hand machine with two nozzles on flexible tubes may be used, but large acreages require the use of horse machines holding about 80 gallons of wash, the double or treble acting pump being driven by the wheels of the machine as it moves along.

The amount of wash required will vary with the machine and the state of the bine: for a fully-grown garden 200–400 gallons per acre will be needed.

Washing should begin as soon as lice are detected on the young leaves, as it is almost impossible to clean the garden if

once the aphis is allowed to get a start. In bad seasons washing may have to be repeated again and again, practically continuously throughout June and July and early August. Every effort should be made to get the plant clean before the hops begin to form, as it is impossible to reach the aphis if once it gets a lodgment inside the cones of the hop. For this reason a late attack of aphis is the most dreaded by the hop grower, because he is then powerless to stamp it out, though washing right up to the time of picking will keep down the numbers which enter the hop. The lower leaves and laterals, and the suckers about the base of the plant, should be stripped away, as they harbour lice and are difficult to wash.

The cost of washing on a large scale amounts to about 20*s.* per acre for both materials and labour, but much depends on the proximity of the water supply.

2.—As the hop aphis in the main migrates from the damson and plum to the hop, the use of the caustic wash, described in Leaflet No. 70, on the fruit plantations in the winter will tend to diminish the attack on the hops in the following summer by destroying the eggs of the aphis. A dilute paraffin emulsion should be used for the damson and plum in the spring against the aphides which issue from eggs that escape the winter treatment.

4, Whitehall Place, London, S.W.,
June, 1903.

Revised, August, 1908.

Leaflet No. 89.

BOARD OF AGRICULTURE AND FISHERIES.

Fluke, or Liver Rot in Sheep.

Fig. *a.* Adult Liver Fluke. *b.* Water Snail (*Limnaea truncatula*). Nat. size.

The disease known as Rot, Liver Fluke, Coathe, and Bane, in sheep, has existed in Great Britain for very many years, and has caused greater losses in this country than any other disease affecting this particular class of animal. The last severe outbreak occurred in 1879 and continued into the year 1880; and in the statistics prepared by the Board of Trade for 1881 there was a falling off in the number of sheep in Great Britain of no less than three and a half millions compared with that given for 1879. This decrease was reported to be mainly due to the prevalence of rot. The greatest losses occurred in England, Scotland being but little affected.

Life History of the Liver Fluke.

The common liverfluke (*Distoma hepaticum*) is found in the biliary passages of the liver of the sheep, where it produces many thousands of eggs, which find their way along the bile duct into the intestines and are expelled with the dung. Those which fall upon dry soil may remain dormant for months, but how long they may retain their vitality is not known; whilst those which reach the water in pools and dykes are at once hatched, and a free swimming *ciliated embryo* is produced. This little organism is provided with a small boring prominence, and as it swims about in the water it searches for a certain species of water snail, to the surface of which it fastens itself, and eventually bores its way into its body. It then becomes the *sporocyst*. The sporocyst grows slowly within the snail, and eventually the germ cells which it contains produce other organisms called *rediæ*, 5 to 8 in number, which eventually escape from the sporocyst and attach themselves to the liver of the snail. Within each redia are

formed from 12 to 20 individuals of the next generation, which are known as *cercariae*. These last-named organisms are somewhat similar to the adult parasites into which they eventually develop, their bodies being flat and oval in shape, but they are provided with a tail. After leaving the redia these cercariae pass out of the body of the snail into the water, where they swim about until they attach themselves to a blade of grass or some other object; subsequently they lose their tail, become encysted—that is, form a case—and remain quiescent until swallowed by the sheep, in whose stomach the wall of the cyst is destroyed. The liberated parasite ultimately finds its way to the liver of the sheep or other animal, and develops into the adult hermaphrodite fluke.

The fluke parasite runs through three reproductive generations, namely:—

1st. The sporocyst;
2nd. The redia;
3rd. The adult fluke.

There is a gradual increase in the number of the organisms derived from each of these generations. For example, the sporocyst containing germ cells gives rise to several (5 to 8) rediæ, and each redia to a larger number of cercariae (12 to 20), while it has been calculated that each adult fluke may produce the enormous number of 45,000 eggs. But for this remarkable fertility there would be comparatively small chance of the entire life-cycle of the fluke parasite being completed.

Symptoms of Rot in Sheep.

In consequence of the extremely slow development of this disease, the fact that the sheep are affected is scarcely ever realized until a long time after they have become infected. The symptoms of the disease progress slowly and are characterised by a very gradual sequence of changes, which vary in accordance with the different stages of the disease, and with the health of the animal. In the primary stage, when the flukes are first developed in the bile ducts of the sheep, their presence causes such an amount of irritation to the liver as is sufficient to produce an increased secretion of bile, which in itself has a tendency to aid the digestive process, and as a consequence the animal may feed well and for a time put on flesh. Soon after, as the number of the flukes increases, the liver begins to enlarge, and the bile becomes slightly tinged with blood. At this period the animal falls off in condition and displays pallor of the eyes and the gums. The appetite, which was formerly very good, now becomes capricious, and the animal loses strength. As the disease advances the sheep becomes extremely emaciated and weak, dropsical swellings are to be found under the jaws, and the abdomen becomes greatly enlarged; while the respiration is short. If a post-mortem examination be made at this stage the bile ducts within the

liver will be seen to be thickened, and their walls when dissected will frequently be found to be calcareous. The bile has a dirty brown colour and abounds with mature and immature flukes and multitudes of ova. The organ is paler, harder and smaller than normal, owing to the contraction of the new tissue. When the disease appears among a flock of ewes it is a very common thing for many to abort, and the mortality in a flock may be very high.

Should the sheep survive this stage, which is quite unusual, a period of convalescence sets in of a slow and generally of an unsatisfactory nature. During its progress the flukes leave the liver and pass out in the droppings, but the pathological changes which their long presence has caused within the liver produce emaciation and debility in the animal. The period of time during which these various changes are in progress may be roughly stated as twelve or more months, *i.e.*, from the time of invasion to the time of disappearance of the flukes.

Distribution of the Fluke.

As a general rule rot is confined to the lowlands, valleys and marshes (except salt marshes), but it may occur in the high lands. It is also more frequent in wet than in dry seasons, and is most prevalent after prolonged rains in the late summer and autumn. It is often associated with the presence of "carnation grass" and similar sedges, and many farmers look with suspicion on land that carries these plants.

From the preceding sketch of the life history of the fluke it will be evident that the conditions necessary for the propagation of the disease in any district are :—

1st. The presence of fluke eggs.

2nd. Wet marshy ground or pools suitable for the hatching of the ova.

3rd. The special snail (*Limnaea truncatula*) to act as intermediate host.

4th. The presence of sheep or other animals to swallow the encysted parasite and thus become infected.

Preventive and Remedial Measures.

1.—As sheep are usually attacked by fluke on wet land, drainage is the most important preventive, and should be resorted to whenever practicable.

2.—The mud, reeds, etc., taken from ditches, pools and ponds when these are being cleaned out should at once be carted away, or covered up with gas lime. Numbers of the snails and their eggs, and often the parasites within them, are destroyed when gas lime is put over this rubbish.

3.—On a farm subject to fluke sheep should always be kept on the drier pastures during the summer and autumn months. If no sound pasture is available the pastures should be divided into two sections, one of which should be grazed by sheep in spring but not in summer or autumn, while the other should carry sheep in summer and autumn but not in spring.

4.—When it is impossible to arrange for grazing the pastures in the way suggested in the last paragraph, sheep should be frequently moved to fresh ground, and the land should never be over stocked.

5.—If infected animals have been pastured on a given piece of ground, it would be advisable to have the droppings spread by chain harrowing, to assist in drying them, and thus hasten the destruction of the eggs; a little lime would assist this.

6.—When practicable, dressing the ground in late summer and autumn with salt alone, or with a mixture of salt and lime, will usually be attended with good results. Sheep should also have access to lumps of rock salt, and where sheep are getting cake, corn, chaff, &c., a little salt ($\frac{1}{4}$ oz. per head per day) mixed with such food should always be provided where fluke is to be feared.

7.—Those sheep which are affected with fluke should be sent to the butcher at once while in a marketable condition, and the others moved on to dry ground. The latter should receive a daily allowance of concentrated food, 4 lb. salt, and 1 lb. sulphate of iron being incorporated with each hundredweight of the feeding stuff.

8.—The livers of the slaughtered sheep should be destroyed, or, if used for dogs' food, they should first be well boiled, as otherwise the fresh eggs might pass uninjured through the intestines of the dog and thus infect the soil.

9.—If rabbits and hares are plentiful on infected ground, they should be kept down, as it is possible that they may spread the disease; there is no proof however that they do so.

10.—Sheep ought not to be purchased from a flock reared on fluky ground.

11.—Whenever rot is suspected in a flock of sheep, sharp observation over the animals will often enable the owner to detect the disease before it has made any serious interference with the health of the majority; and if on a post-mortem examination of the first suspected cases flukes are found in the bile ducts of the liver, it becomes an important question to the owner whether it would not be to his interest to slaughter the whole of them at once, while they are in a marketable condition, rather than allow the disease to continue, since by leaving the animals alive they will probably be the means of permanently infecting his pastures.

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Leaflet No. 90.

BOARD OF AGRICULTURE AND FISHERIES.

The Pith Moth.

Much damage may be caused to young apple, and it may be to other fruit trees, by the caterpillars of the Pith Moth, a small moth belonging to the group *Tineinæ*. The moths of the group *Tineinæ* have narrow wings bordered with long fringes, the fringing being most marked on the hind pair of wings.

The caterpillars of the Pith Moth burrow into terminal and other shoots, and buds, the fruit spurs especially suffering. Infested buds fail to develop, the leaves of tunnelled shoots flag, and the shoots wither and fall away (Fig. B). The caterpillars of another small moth, the Bud Moth, one of the *Tortricidæ*, are also troublesome on fruit trees, and their work is sometimes confused with that of the caterpillars of the Pith Moth. The Bud Moth caterpillars, however, spin the leaves together, making leaf-nests.

Description.

Moth.—The moth (Fig. A) varies in size and has a wing expanse of from $\frac{2}{5}$ to $\frac{3}{5}$ of an inch. The front wings are almost entirely black, or blackish, with white streaks and scales; the hind wings are grey and have long delicate fringes.

Larva.—The caterpillar (Fig. G) is dull reddish or flesh-brown, with the head, the first segment, and the last segment deep brown. Segments two and three show pale brown spots, while the abdominal segments have six brown bristle-bearing spots. The full-grown larva measures one-third of an inch.

Pupa.—The pupa (Fig. D) is of an ochreous hue; the head and front of the thorax and the tip of the body are mahogany red. It is cylindrical in form and measures about one-fourth of an inch long. On the under surface of the last segment but one are two blunt processes, separate and diverging outwards, and hairy at their tips (Fig. C); the eyes are black, and the wing cases and legs long, the former being pointed.

Distribution.

The distribution of the moth in our country may be given as from Lancashire southwards. Theobald has recorded it from Kent, Sussex, Surrey, Devonshire and Gloucestershire, and Carpenter has recorded it from Donnybrook, Dublin.

THE PITH MOTH.

A, Moth (magnified, line shewing natural size); B, attacked apple shoot, the upper portion shrivelling up and dying away; C, processes on pupa (magnified); D, pupa (magnified) in a shoot; E, larva (natural size) in a shoot; F and G, larvæ (magnified).

Life-history.

The moths issue chiefly in July. It is believed that the eggs are laid on the leaves of the apple, and on these the caterpillars may at first feed on hatching. Before winter, the caterpillars, still very small, bore into the shoots, and pass the winter just below the outer bark, the position being marked by the presence of a small blister *and a distinct round hole opening into or near the blistered area.* Early in the next year, the caterpillars tunnel into the pith of the shoots and fruit spurs, and work upwards in the pith. They are full grown towards the end of June, when pupation takes place in the tunnelled shoots. After the emergence of the adult the empty pupa case may be seen projecting from the dead shoots.

Treatment.

The best treatment consists in (1) prevention by means of winter pruning, the hole in or near the blistered area showing the parts to be cut away; and (2) hand-picking and burning the attacked shoots and spurs in spring.

More than one species of moth appears to be harmful in the manner described above. The subject is at present under investigation.

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BOARD OF AGRICULTURE AND FISHERIES.

The Pine Beetle (*Hylesinus piniperda*, L.).

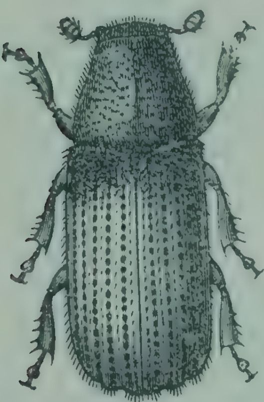

Fig. 1. Pine beetle magnified about six times.*

This is one of the most destructive of forest insects, and in this country is met with wherever pines are grown.

Description.

The Beetle.—The mature beetle (Fig. 1) is about one-fifth of an inch long, dark brown or almost black in colour, and thinly covered with brown hairs springing from little tubercles, which, on the wing-cases, are disposed in rows between lines of punctures. These rows of tubercles are continued to the very edge of the posterior margin of each wing-case, except in the case of the second row on each wing-case, counting from the middle of the back, where the hairy tubercles cease at the point where the wing-case begins to bend down towards the apex. The discontinuance of the tubercles in these two rows is the main point of distinction between this insect and *H. minor*, Htg. The latter, however, is as rare as the former is common. The feelers (antennae) are rusty brown in colour, relatively short, and end in jointed clubs. The thorax, except in the middle, is thickly covered with shallow punctures, but not disposed in rows as on the wing-cases.

* The illustrations are reproduced, by permission, from Trans. High. & Agric. Soc. of Scot.

The Larvæ.—The larvæ are white, bent, and footless, with a brown head.

Life History.

The beetles pass the winter under a variety of cover, and take wing during sunny weather in March and April. They at once congregate for breeding purposes on the bark of pines that have died or that have been felled during the previous autumn or winter. Trees that have been dead longer than the period indicated are not attractive to the insects. All kinds of true pines, such as the Scots Pine, Black Austrian Pine, &c., are used for breeding purposes; and occasionally, though very rarely, the spruce, larch, and other conifers are also utilized. Trees or boughs of a size to carry thick rough bark are chiefly infested by the insect for purposes of breeding; but young trees, or branches with comparatively thin smooth bark, may be attacked. The

Fig. 2. Mother and larval galleries, showing two air-holes, natural size. The male keeps near the entrance, while the female carries on the work of excavation.

insects pair and proceed to bore into the bark, making a passage between the bark and the wood, the latter, however, being hardly broken. This passage has a slight bend at the starting-point, but afterwards is nearly straight (Fig. 2). It is usually about four inches long, and is generally supplied with one or more air-holes besides that by which the pair of insects entered. In making this gallery the dust is thrown

to the outside, where its presence quickly attracts the attention of an experienced observer.

As the gallery is proceeded with the female beetle lays eggs, depositing them alternately on either side, and laying in all about 100. On hatching from these the larvæ proceed to gnaw out tunnels, in the cambial region, at right angles to the mother gallery. When full fed the larvæ pupate at the end of their tunnels in a bed hollowed out in the bark; where the bark is thin the outermost wood may be excavated. The beetles when ready bite through the bark. As it often happens that a very large number of beetles breed in the same tree, the surface of the bark after the young beetles have emerged looks as though a charge of shot had been fired into it.

So far as dead or dying trees are concerned, the action of the insect up to this point is not of serious economic importance. So long as it can get such trees in which to breed, it will not attack healthy trees, but should suitable breeding material not be present it may make its breeding galleries in comparatively sound stems, which will soon be seriously crippled, or killed outright.

The young beetles appear in June and July, and they may do one or other of two things. They may fly off to other

Fig. 3. Pine shoot with slice removed to show passage made by the beetle.

pine stems that have been felled or have been dead for a few months, in which case they pair and breed just like their parents, the earliest of the beetles of the next brood appearing in late September or October. In such an event there

is what is called a double generation, that is, two broods in a single season. But more frequently the young beetles that appear in summer do not breed in the year in which they are hatched. In this case they fly singly to the young shoots of the Scots or other pine, and into such shoots they bore, usually two inches or so beneath the terminal bud (Fig. 3). Having reached the pith the beetle bores upwards, but the passage thus made is only occupied for food or shelter, never for breeding, which is only performed underneath the bark of trees in the manner described above.

As a result of the leading shoot of a stem or branch being hollowed out in the centre it generally dies, or is broken off by the wind, and the trees become much deformed. They lose a considerable quantity of their foliage, and the yield of cones may also suffer to a serious extent, a matter of importance in natural regeneration. It is to this action of the beetle that the chief sylvicultural damage is due. Trees so affected become characteristically mis-shapen, and are easily recognised, even at a long distance. Underneath infested trees, especially after a high wind in autumn, the ground will often be found thickly strewn with the tips of shoots, each with a cavity in the centre, and not infrequently containing the beetle. On young, vigorous trees, especially in a sheltered situation, the shoots do not so frequently break off, but the sickly appearance of the leaves, and an outflow of resin from the entrance-hole, readily attract attention to the damage, and on cutting the shoot open the beetle will often be found at work in the central gallery.

The result of the action of the insect in destroying the ends of the branches, and frequently causing them to drop off, has earned for it in Germany the name of Wood Gardener or Tree-pruner, a designation first suggested by Linnæus.

Young trees, though severely crippled and reduced to the condition of mis-shapen bushes, are not often actually killed by the pine beetle; but old trees, whose shoots are more exposed to the wind, and being thin, are easily broken off when injured, are often completely destroyed by the persistent attack of this insect. Such a result will most frequently be observed in the neighbourhood of a saw mill, or of any place where pine logs are stored. Often, when a small proportion of standard pines are retained to grow when a wood is felled, it is found that such standards become unhealthy and soon die. This result is due to the fact that the felling of the wood has provided the insects with abundant opportunities for propagation (stumps, stools, stems, &c.), and from these in the month of June the standard trees are invaded by swarms of beetles. If the change that is induced in the appearance of their crowns be observed, the appropriateness of the name Tree-pruner will be at once apparent.

Preventive Measures.

Widespread and destructive as this insect is under irrational methods of forestry, it is by no means difficult to combat. This is secured either by preventing its getting suitable material in which to breed, or by providing it with such material, but taking care that the young beetles are destroyed before they have escaped from the places where they are bred.

Most trees are felled in autumn and winter, and to leave pines lying in their bark in or near woods till the middle of the following summer is a sure way to propagate this and many other destructive forest insects. There need be no fear of the pine beetle breeding in stems from which the bark has been removed, but the barking of winter-felled pines is a somewhat expensive proceeding. The removal of the trees, or their conversion before the month of June, should always be attended to, but the ideal method of procedure is as follows. The trees felled in autumn or winter should be allowed to remain in or near the wood till the month of May, by which time they will have attracted most of the pine beetles in the neighbourhood. By the end of May all such trees should be barked, and as the stems will then be thickly beset with larvæ, the bark can be removed quite easily. In delaying the process of barking till May the logs are not only rendered unfit to serve as future breeding places; but, what is most important, they are utilized as lures or traps, to which a large proportion of the beetles in the neighbourhood are attracted, and in which they are subsequently destroyed. On no account, however, must barking be delayed beyond the end of May. The bark removed may be deposited so that its inner surface, where the larvæ and pupæ are found, is freely exposed to the sun and birds, and if this is attended to there is small chance of any of the young insects escaping. It is, however, always safer to burn the bark which has been stripped off. When the bark is very thick there is a likelihood of the immature insects completing their development in the bark after it is stripped off, and, in such a case, burning should always be undertaken.

All pines that die in the course of the summer should be felled and barked within two months. It should be remembered that there is a certain irregularity in the issue of the adult beetles, and it would therefore be wise to arrange for a series of trap-trees from April onwards, two months always being allowed before barking.

Small brushwood does not offer satisfactory breeding facilities for this insect, but it may serve the purpose for others, so that it is well to destroy it. Large branches, however, should be treated as recommended for stems. The Pine Beetle will also breed in the part of the stools above

ground, and in the month of May the bark of stools should be pressed off by means of a spade or other suitable tool, and, being generally thick, should be burned.

Two beetles, *Clerus formicarius* and *Rhizophagus depressus*, attack and destroy *Hylesinus piniperda*.

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BOARD OF AGRICULTURE AND FISHERIES.

Bunt and Smut.

Both bunt and smut are fungus diseases of cereals, and annually cause much damage. Bunt (*Tilletia*) chiefly attacks wheat, and is characterised by the grains being filled by a black mass of fungus spores, which give a fœtid odour, especially when rubbed. Ears that are attacked are lighter than sound ears, and therefore stand more erect. They also remain longer green as harvest approaches. So long as the ears are undisturbed the black spore-masses remain unseen; it is only when they are rubbed or bruised in the process of thrashing that they allow the spores to escape.

Smut (*Ustilago*) attacks all cereals, and is characterised by the grains being filled and destroyed by black dusty spores, which, unlike bunt, are quite conspicuous on the undisturbed plant. It is most common on barley and oats, where it may attack a large proportion of the ears. There are several varieties of this fungus, but the distinctions are of no importance to the farmer.

It was at one time believed that infection was in all cases effected when the host-plant was in the seedling state, the fungus growing in the tissues of the host, until ultimately the well-known "smut" or "bunt" appeared in the ear. For this reason it has long been the practice to treat the seed with some substance with the object of destroying spores adhering to the surface of the grain, and the method is still valid in the case of the oat smut.

Quite recently, however, it has been proved that the seedling plants of wheat and barley are not attacked by the smut spores, but that infection takes place through the flowers. Treatment of the seed of these cereals for "smut" is therefore useless, and no method has yet been devised for combating the "smut" of wheat and barley.

In the case of the oat "smut," prevention of the disease should take the form of treating the seed in such a way that the spores are destroyed before sowing.

The best method, to which recourse has been had of late years, with great success, is to use a solution of formalin, at the rate of 1 pint of formalin to 36 gallons of water. The seed is placed in a bag and dipped into the solution, where it is allowed to remain for 10 minutes, being afterwards spread out to dry. One pint of formalin, costing 1*s*. 6*d*. to 2*s*., is sufficient for the treatment of about 30 bushels of seed.

For "bunt" in wheat the seed should be dressed with formalin, as described above for the oat "smut," or with bluestone. The grain may be poured into a barrel or other receptacle containing a half per cent. solution of bluestone (copper sulphate) and left there, with frequent stirring, for 12—16 hours, or it may be spread on a floor and sprinkled with a 10 per cent. solution of the same material. The latter is the method most commonly practised in this country, the mode of procedure being to empty a sack (four bushels) of grain on a clean wooden floor and water it with 1 gallon of water in which 1 lb. of bluestone has been previously dissolved. The seed should be turned during the progress of the operation, and thereafter it should be turned two or three times, after which it may be spread out in a thin layer till it is dry enough to sow.

When treated with bluestone or formalin solutions, a certain percentage of the grains are destroyed, but as these have frequently been previously damaged in the process of thrashing or otherwise, and are therefore likely to produce weak plants, their total destruction is of less consequence. Seed that has been much rubbed in the thrasher suffers most in steeping. The loss by treatment with bluestone can be somewhat mitigated by dusting powdered lime on the grain after it has lain for a sufficient time in contact with the solution.

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BOARD OF AGRICULTURE AND FISHERIES.

Farmyard Manure.

The substance that goes by the name of farmyard manure, fold manure, dung, or muck, chiefly consists of (*a*) the material that was used as litter, usually straw, sometimes peat, fern, sawdust, &c.; (*b*) the food that passed through the animals in an undigested condition and has been voided in the solid form; and (*c*) the urine, which contains that part of the food which the animals digested but did not retain in their system. The urine also contains in part the waste of the tissues of the animal's body. The proportions of these parts will vary with circumstances. For instance, when it is the object of the farmer to break down as much straw as possible, a relatively large amount of the farmyard manure will consist of litter, but where litter is used very sparingly—as in upland dairies—the manure will consist very largely of the solid and liquid excreta.

Manure Produced by Stock.

All food contains more or less water; even in such substances as grain or cake one-seventh or one-eighth, while in others, like turnips, nine-tenths is water. Neglecting this water, it may be said that for every 100 lb. of food that an animal consumes, about 50 lb. reappear in the dung or urine; the other 50 lb. being burned up in its system, becoming gas or water, or being stored up in its body as bone, flesh, fat, hair, &c. A bullock or cow—weighing, say, 9 cwt.—will consume daily, if on full ration, about 24 lb. of absolutely dry food, as for example :—

56 lb.	Roots (90 per cent. water) ...	=	5·6 lb. dry.
6 ,,	Cake or Meal (12 per cent. water)	=	5·3 ,,
16 ,,	Hay or Straw (16 per cent. water)	=	13·4 ,,
	Total ...		24·3 lb. of dry matter.

One-half of this, say 12 lb., will reappear as manure, and to this has to be added the whole of the dry matter in the litter, say 10 lb., making the daily output of dry matter in farmyard manure 22 lb. Needless to say, it may be much more or much less, depending on the age and size of the animals, and on the way in which they are fed and littered. Ordinary farmyard manure is, of course, not dry; on the contrary, it contains about 75 per cent. of water. The daily output will therefore weigh not 22 lb. but 88 lb., say $\frac{3}{4}$ cwt. Thus on a six months' keep the amount of farmyard manure yielded will be about 7 tons. This calculation applies to

full-grown cattle; if the stock consists, as it generally does, of a fair proportion of younger animals, the output per head may be only 3 or 4 tons. It follows that on a farm with a mixed stock of 50 head, including 3 or 4 horses, enough dung should be produced during winter to give a dressing of 10 or 12 tons per acre to about 15–20 acres of land, or 3–4 acres less when allowance is made for loss during storage.

Principal Constituents of Farmyard Manure.

From the manurial point of view the three substances that are of most importance in the food are nitrogen, phosphoric acid, and potash. Although only one-half of the solid matter in the food reappears in the manure, at least three-quarters of the nitrogen, and nine-tenths of the phosphoric acid and potash, are voided. These proportions will be considerably reduced in the case of very young animals, and increased in the case of full-grown fattening cattle. Of the nitrogen that passes through an animal a larger proportion finds its way out in the urine than in the solid excreta. The same is true of the potash, whereas the phosphoric acid—*i.e.*, the phosphates—are chiefly voided in the dung. It will thus be seen that two of the three valuable elements of plant-food are more abundant in the liquids than in the solids of animal excreta, and, not only so, but, pound for pound, the substances in the liquids are much more valuable for crops because they are much more readily available. The Rothamsted experiments have shown that much of the nitrogen in the solid part of dung can hardly be said to be of any use to plants, whereas the nitrogen of the liquid portion is almost as active and therefore as valuable as nitrate of soda or sulphate of ammonia.

In a ton of ordinary farmyard manure there is as much nitrogen, phosphate, and potash as in twelve or fifteen shillings' worth of artificial manure, and if a ton of dung is not usually valued at even half these figures this is chiefly because a large part of the three substances mentioned never becomes available, or is lost before crops can make use of it. True, a ton of farmyard manure is more expensive to handle than 2 or 3 cwt. of artificials, and this, of course, reduces its relative value; but, on the other hand, farmyard manure has a beneficial influence on crops just because it is a heavy bulky substance, so that these two considerations may be held roughly to balance or cancel each other.

Variation in the Quality and Character of Dung.

The quality and general character of dung is affected by:—

1. *The Kind of Food.*—Generally speaking, the richer a food is in fertilising materials, especially nitrogen, the

greater is the proportion that is digestible, and the richer is the dung produced.

2. *The Kind of Animal.*—Horses produce dry, hot dung that ferments and acts quickly, but does not last long, whereas the dung of cattle and pigs is cold, slow-acting, and more durable. The dung of young stores and dairy cows is rather poor in all the important elements of plant-food, because, in the former case, these elements have, to a relatively large extent, gone to form bone and muscle, while in the latter case they have found their way into the milk. For instance, to quote the Rothamsted figures, while the excreta of a fattening bullock getting decorticated cotton cake will contain about 97 per cent. of the nitrogen, 96 per cent. of the phosphoric acid, and 99 per cent. of the potash present in the cake, the corresponding figures for a milk cow are only 87 per cent. for the nitrogen, 89 per cent. for the phosphoric acid, and 86 per cent. for the potash. This means that for every 3 lb. of nitrogen, 4 lb. of phosphoric acid, and 1 lb. of potash that the fattening bullock abstracts, the milk cow appropriates 13 lb., 11 lb., and 14 lb. respectively.

3. *The Age of Dung.*—Rotten dung is richer and more active, provided it has been properly "made," than comparatively fresh undecomposed material.

4. *The Manner of Storage.*—Properly-managed dung is more valuable than that which has been mismanaged, in which considerable loss of valuable ingredients occurs.

5. *The Nature of the Litter.*—Farmyard manure varies considerably in composition according to the character of the material used as a litter for the animals. Among litters which are employed may be mentioned straw, peat moss litter, bracken, hop bine, leaves, spent tan, sawdust, and these vary in their power of absorbing the valuable liquid portions of the manure, as well as in their own composition.

Treatment of Dung in the Homestead.

In the management of dung in the homestead attention should be given to :—

1. *The Prevention of the Escape of Liquids*, for these hold the larger and much more valuable part of the plant-food. They may drain into the ground if the floor of the yard or dung-heap be porous, therefore the surface on which the mass rests must be water-tight. More frequently, perhaps, they are allowed to run away in a surface stream, and unless this can be led on to a meadow or other field, the loss may be very serious. The floor of the dungstead should not only be impervious to the passage of liquids, but it should have a distinct slope backwards, so that the front is two or three feet higher than the back. No doubt concrete is the most satisfactory form of floor, but no great waste, if

any, will take place through a foot of well-beaten clay overlaid by rubble.

Many farmers prevent loss due to escaping liquids by leading these directly on to the land, or by conducting them to a tank which is periodically emptied into a liquid manure cart and distributed over the land. If the character and lie of the fields suit such methods of treatment, they are in every way commendable, but local circumstances often make it difficult or impossible to carry them out.

2. *Over-heating*, which is productive of loss in various directions. The heat that is always more or less associated with a mass of dung shows that actual burning is going on, and, in the process, nitrogen escapes into the air. The weight of organic matter is also reduced, and as part of the value of farmyard manure is due to its being a bulky organic substance, it is undesirable to have this substance largely consumed in the dung-heap. During a winter's storage the loss of weight will usually be about 20 to 30 per cent., but it may be double this, and when the loss is excessive the capacity of the mass to suck up and retain liquids is correspondingly reduced. Moderate decomposition cannot be avoided, and is not to be regretted, for if no loss has occurred by drainage, and but little by the air, the smaller mass will contain practically all the original plant-food, and this, too, in a more portable and convenient form. If, for instance, 5 tons have shrunk to 4 tons the value of the latter quantity should be as great as the former, so that if 5 tons of fresh dung are worth 15*s.*—*i.e.*, 3*s.* per ton—4 tons of matured dung will still be worth 15*s.*—*i.e.*, 3*s.* 9*d.* per ton.

Over-heating is avoided by keeping the mass well compressed ; and this is secured by the treading of animals—as in yards, courts, or boxes,—or by wheeling each barrow-load or cart-load over what was there before, or by loading on soil or rotten turf. The mass should also be kept saturated with moisture, and this is best secured by preventing the escape of liquids. With dung of a very dry character (horse manure), especially in a covered dungstead, it may be desirable to add water, but only if there is no chance of superfluous moisture escaping by drainage.

If manure is stored in a compact, deep dungstead, with a properly constructed floor, and if care be taken to prevent its getting more water than falls directly on it in the form of rain or snow, there is no need to cover it in. Loss by excessive washing can be better prevented by other means than by erecting a roof over the mass. It is obvious that the advantages of a covered dung-heap will be the greatest in a district of heavy rainfall, but in any case it is doubtful if it will pay to provide a roof for the dungstead unless it can be also used as a cattle-shed.

Over-heating and excessive loss of weight are obviated by compression and saturation, simply because the dung-heap

under these conditions contains comparatively little air, and air is a necessity of fermentation and decomposition.

To bring raw manure into a rotten condition, farmers often turn it over once or twice, the result of which is that air permeates the whole mass, and great heat is developed, with corresponding loss of weight. No doubt there are circumstances where such treatment is expedient; but, considering the cost of labour and the loss of organic matter, and, to some extent, of nitrogen, it is probable that the process is often performed when it would be better avoided. The familiar example of the slow combustion of a "backed" or "banked" fire of coals is strictly comparable with what takes place in a well-packed mass of dung, while in both cases rapid combustion, with concurrent disappearance of solid material, will follow vigorous stirring.

3. *Equality of Composition* throughout the whole mass should be secured as far as possible, or otherwise the best results both in the heap and on the crop will not be secured. The dung from the stable, cow byre, feeding byre, store byre, and piggeries has, in each case, its own characteristics, and the mingling of all will produce, on the whole, better material than having the horse dung in one part, the cattle dung in another, and the pig dung in a third. The wet, inert, cold character of byre dung will add moisture to the stable dung and prevent its being over-heated ("fire-fanged" it is sometimes called), while the rich manure from the feeding boxes will improve the quality of the dung of the store cattle.

Conservation Agents.

From time to time attention has been directed to the prevention of loss in manure heaps through adding gypsum, superphosphate of lime, kainit, or sulphuric acid, but though good results have occasionally followed their use, it is now recognised that all are open to objection, and they are not recommended.

A good preservative for dung is loamy or peaty soil. It fixes ammonia, consolidates the mass, and sucks up and retains liquids. Needless to say, soil so employed must not contain the seeds of troublesome weeds or the germs of plant-diseases, such as finger-and-toe. Moss litter or peat is also an excellent fixer of ammonia and absorbent of liquids, and, if for nothing else than to improve the manure heap, it is a good plan to have a little in use for some of the live-stock. Such peaty manure, unless it is being used in a yard, should daily be spread in the dungstead, and the quality of the resulting mass will be thereby appreciably improved.

It has also been found that a layer of old well-rotted farm-yard manure, when used as the foundation for a new heap, has a distinctly beneficial effect and results in smaller losses of nitrogen.

Treatment of Dung in the Field.

Field Storage Heaps.—To save carting in spring, or to empty the dungstead or the yards, it is a usual practice, in the course of the winter, to form large field storage heaps. In many cases, this practice is thoroughly justifiable, though the fact cannot be overlooked that the opportunities for loss in such heaps are much greater than in a proper dungstead, so that field heaps should only be formed if they are the means of gaining an important end. Where these heaps must be formed they should be placed on firm, level ground, and they should be made as deep and firm as possible. The so-called "draw heaps," on to which each cart-load is drawn, thereby consolidating the mass, are the best. Subsequently the sides should be trimmed up, and the whole should be covered with a layer of soil about a foot thick. Such a covering consolidates the mass, prevents to some extent ammonia rising in the air, and runs off rain water.

Uniform Distribution.—When dung comes to be spread on the land, it should be distributed as equally as possible. Sometimes, unfortunately, one sees great lack of care in this respect. In some districts dung is roughly spread straight from the cart, and if the manure is at once properly spread by hand labour the results are satisfactory. In other districts, and more frequently, it is laid down in small heaps about six yards apart. If it is immediately spread this system is usually free from objection, though if the dung is very old, or if it is largely made from moss litter, the spots on which the heaps rest are apt to be left over-manured, and especially is this the case on rough meadows. Too often, however, one sees these small heaps lying for days, and even for weeks, unspread, with the result that the rain washes the substance of the dung into the patches on which the heaps rest. These patches are consequently over-manured, whereas the rest of the field, being supplied with impoverished dung, suffers from insufficient nourishment.

With farmyard manure, even more than with artificials, the farmer should so arrange matters that the quantity of dung at his disposal is distributed over as large an area as is consistent with practical convenience. For instance, twenty tons of dung spread equally on two acres will give a much better return than the same quantity spread on one acre, and yet this rule is often neglected.

Best Time to apply Dung.—As regards the time of year when dung should be applied, much depends on the circumstances of the particular case. By far the greater quantity of dung goes on to meadows and green crops, and it may be said that in the former case autumn or early winter is the best time to make the application. The complete stocking of the ground with plants obviates

much loss of soluble matters by washing. On farms entirely under grass there is no choice but to employ the dung on meadows or pastures, and on such farms it would be bad practice not to cart out all available dung in autumn. Of course, the dungstead will again fill up during winter, and on the whole it is probably better to distribute this additional supply in spring than to leave it in the heap, subject to waste and yielding no return, till the following autumn. Late spring dressings, however, unless the dung is very "short"—*e.g.*, dung made with moss litter—interfere with the work of the mowing-machine, though this can be avoided by chain harrowing and raking the roughness off two or three months after dressing.

In the case of green crops part of the dung may with advantage be ploughed in during autumn, but only on clean land. If foul land, and especially foul strong land, has to be cleaned in spring it will be found that autumn dung, by holding moisture, retards the getting of the land into condition in spring. Autumn manuring would further increase the work of cleaning foul land by promoting the growth of weeds. Again, the action of the cultivator brings much of the dung to the surface, and this, being collected with the weeds, is carted off the land, or possibly wasted by burning. Farmyard manure ploughed in during autumn will decay more rapidly—especially in a mild winter—than if left in the dung-heap, so that a relatively larger proportion will be available for the use of the first crop. On this account the succeeding crops will not get so much benefit, and this fact has to be borne in mind in estimating the respective advantages of autumn and spring dressings.

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A pamphlet containing 10 *leaflets dealing with Manures and Feeding Stuffs can be obtained from the same address, price* 1*d., post free.*

Leaflet No. 94.

BOARD OF AGRICULTURE AND FISHERIES.

Millipedes and Centipedes.

FIG. 1.

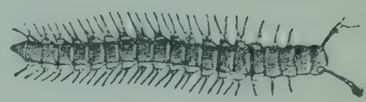

FIG. 2.

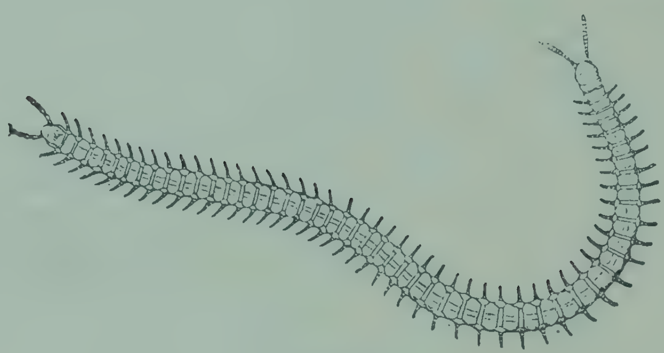

FIG. 3.

Figs. 1 and 2, Millipedes (1, *Julus pulchellus*; 2, *Polydesmus complanatus*); Fig. 3, Centipede (*Geophilus subterraneus*).

Millipedes and centipedes belong to a group of the animal kingdom known as the *Myriapoda*. They are not far removed, in relationship, from insects, but are distinguished by their body showing only two regions; a head, followed by a number of resembling rings or segments, all of which carry one or two pairs of legs.

Both millipedes and centipedes may be found in dark and damp places, under stones, bark, or decaying wood, in loose soil, at the roots of plants, whilst they are especially attracted by decaying vegetation, such as heaps of leaf-mould, rotting stalks, &c. There are differences between them both in food habits and structure, and as, on the whole, centipedes are useful while the millipedes may be distinctly harmful, these distinguishing characteristics should be noted. They may be contrasted thus :—

Centipedes.	*Millipedes.*
Antennæ longer.	Antennæ shorter, not more than seven joints.
Body usually flattened.	Body round.
Bases of legs wider apart.	Bases of legs close together.
One pair of legs to each segment.	Two pairs of legs to each seeming segment, except the front four.
Poison claws showing below the mouth, with poison glands.	No poison claws.
Active and carnivorous, feeding on insects, insect larvæ, worms, snails, and slugs.	Vegetable feeders, destructive to the roots of plants and to underground storage organs, like tubers and bulbs.

Millipedes are sometimes known as "false-wireworms," but they can be readily distinguished from the true wireworm (Leaflet 10) by the great number of legs.

Description and Life-History.

Millipedes.—The most injurious millipedes belong to the families *Julidæ,* which have more than 30 rings to the body, and *Polydesmidæ*, with 19 body rings. The most troublesome millipede is *Julus pulchellus* (Fig. 1). This is nearly half-an-inch long, slender, about the thickness of a fair sized pin, pale yellowish-pink in colour, with a double row of crimson or purplish spots on it. *Julus terrestris*, another common species, is black and has a pointed tail. These *Julidæ* feed upon all manner of roots. The smaller *Julus pulchellus* also eats into potatoes and lily bulbs, often hollowing them out completely; the larger species, according to some observers, also feed upon snails, slugs, and some insects. The common species of *flattened* millipedes, *Polydesmus complanatus* (Fig. 2), is of a pale purplish-white to dull rosy tint, with the sides notched, and may be when mature about an inch long. This species can also be very mischievous at the bulbs and roots of various plants.

The female *Julus terrestris* deposits her eggs from May to July in a nest made of pieces of earth fastened together with saliva; this nest is round in form, is smooth inside and rough outside, and has a small hole at the top through which the eggs are passed. The eggs vary in number from 60 to 100. The hole is then stopped up and the eggs mature in from 10 to 14 days. The young millipedes have only three pairs of legs, the others appear in groups by degrees. Growth in a millipede takes place by lengthening at the posterior end, the growth evidently taking place between the penultimate and last segments.

Centipedes.—Centipedes, or *Chilopoda*, are beneficial, the diet being carnivorous chiefly, *e.g.*, snails, slugs, and ground insects. Two of the commonest genera are *Lithobius* and *Geophilus* (Fig. 3). The eggs of *Lithobius* are laid from June to August; they are about the size of a number five shot, spherical in form, and covered with a sticky slime. The female after laying an egg receives it—as Sinclair has shown—on two little hooks at the hind end of the body and rolls it round and round until it is all covered with soil, when, resembling a grain of earth, it is safe from the voracious male. A small number only are laid by each female; the males frequently devour the eggs before the female coats them with earth. In other genera the number of eggs probably varies. *Geophilus* is said to lay its eggs in an earthen cell.

Methods of Prevention and Remedies against Millipedes.

1.—These pests are frequently distributed with leaf-mould, which should, therefore, be examined before being used, and if found to contain them should be mixed with lime.

2.—Their numbers in the field may also be lessened by broad-casting lime over the surface and working it into the soil.

3.—Soot-and-water, in the proportion of a handful of soot to half-a-gallon of water, is found to drive them away from the roots of garden plants for a time.

4.—They may also be trapped in numbers by placing just under the ground, near the plants they are attacking, pieces of mangolds which have been scooped out. The millipedes swarm over the baits and may then be collected and destroyed.

5.—A certain way of killing them on small areas is by injecting bisulphide of carbon into the soil.

6.—They may be poisoned by baits of decaying cabbage leaves or decaying roots soaked in Paris green and placed here and there in the garden.

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BOARD OF AGRICULTURE AND FISHERIES.

Ringworm in Cattle.

Ringworm is a disease which may attack any of our domesticated animals, but is most frequently seen on cattle. It is also transmissible to human beings.

It evinces a decided preference for young animals, such as calves and yearlings, and for stock that are in poor condition.

The disease is due to the attack of a microscopic fungus (*Trichophyton tonsurans*) which establishes itself at the base of the hair, which in consequence becomes brittle and breaks off. The presence of the fungus also causes the epidermis of the skin to become thickened and wrinkled. In this way bare, gray, scaley patches, two inches or more in diameter, appear upon the animal, especially on its head and neck, though also on other parts of its body.

As has been indicated, animals in low condition are most apt to be attacked, so that a preventive measure is to keep young stock in good condition.

The disease is usually not difficult to cure, the substances employed for this purpose being very varied. In order to enable any substance employed to get thoroughly into contact with the fungus, the part attacked should first be well washed with soft soap, or better still, with a solution of washing soda. The patch may then be dressed with one or other of the following mixtures :—

(*a.*) Train oil, five parts, and sulphur, one part.

(*b.*) Lard, five parts, and sulphur, one part.

(*c.*) Lard, five parts, and iodine, one part.

(*d.*) Lard, five parts, and oleate of copper, one part.

(*e.*) Soft soap, five parts, and sulphur, one part.

Other substances employed, more or less successfully, are paraffin oil, lime made into a paste, and mercurial ointment.

The last-named, however, is highly poisonous, and should only be used under the advice of a veterinary practitioner.

The disease is very contagious, and will linger on pastures, the woodwork of stalls, rubbing posts, &c., for many months. The woodwork should therefore be cleansed by washing with a weak solution of carbolic acid, or some other disinfecting agent.

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BOARD OF AGRICULTURE AND FISHERIES.

Milk Fever or Parturient Apoplexy.

Parturient Apoplexy, also called Milk-Fever, Dropping after Calving, etc., is a disease of cows, more especially of milking breeds; and chiefly occurs at the time when they have attained their fullest milking capacity. It has been recognised for generations and has been a fruitful cause of loss to the agricultural community, the deaths in many instances averaging from 40 to 60 per cent. of all cows attacked.

Symptoms.

The disease generally commences within from 12 to 48 hours after an easy parturition, but it may be delayed for a few days longer. (In only extremely rare cases has it come on *preceding* parturition, or *later than* six days afterwards.)

The first noticeable symptom is sudden cessation of feeding, rumination, and lacteal secretion, with uneasiness, moaning, a dull expression of the eyes, paddling of the hind legs, rapid breathing, swaying from side to side, and knuckling over of the fetlocks. Later on the cow drops. This may be succeeded by a stage of excitement, characterised by throwing about of the head and bellowing, but more frequently the cow passes into a semi-conscious sleepy condition, and is unable to rise. She remains in this state, moans slightly, and assumes a characteristic posture, with her neck flexed laterally and her nose touching the point of her shoulder.

As the disease progresses the cow becomes comatose, is unable to see, to swallow, or to void excreta; distension of the belly sets in and death supervenes.

Methods of Prevention and Treatment.

The nature of preventive treatment largely depends on the conditions under which the animals are housed; but the principle involved is always to bring the animal into a condition of body most nearly resembling the natural.

If the cow is very fat, reduce her condition by diminishing the amount and the richness of the food supplied for a week or so, before and after parturition; this may be assisted by a judicious use of mild purgatives.

If the surroundings are suitable, the cow, for a fortnight before she is due to calve, might be turned out to graze in a field in which the grass is not too abundant and where she would require to move about in search of her sustenance.

Cows coming near the calving should be kept on a cooling, laxative, and somewhat restricted diet, *e.g.*, roots, weak mashes, treacle. Avoid giving cows, for a couple of weeks before calving, much dry food, especially chaff and "light" corn.

Some dairymen believe that they secure a high degree of protection from an attack of the disease by rather frequent milkings of the cow after calving, and by not abstracting more milk at a time than would naturally be taken by a calf.

It may be pointed out that the application of preventive methods is of most importance before the third, and especially the fourth and fifth, calvings; heifers and old cows being less subject to attack.

In the case of cows which might be considered as predisposed to the disease, there is reason to believe that the iodine injection mentioned below, used as a preventive immediately after calving, would be attended by good results.

When the symptoms are recognised, a veterinary surgeon should at once be called in. Before he arrives a simple enema should be given and a good dose of Epsom salts administered. The animal should be supplied with a comfortable bed.

The methods of treatment adopted to combat this disease have been many and various and the success which has attended these methods has, to say the least of it, for many years been disappointing. Latterly, however, very good results have been obtained by adopting the following, viz., "Schmidt's Treatment." This consists of the injection (by means of a special apparatus) through the teats into the mammary glands of a solution, the basis of which is a preparation of iodine, followed by a further introduction of an abundant supply of air, and thereafter careful and judicious massage of the udder. An alternative treatment is the substitution of simple filtered air for the solution before-mentioned; this is also injected by a special apparatus. By either of these methods the percentage of recoveries has been much increased, and if promptly and properly applied, a large number of recoveries may be expected.

As the application of this treatment requires special knowledge and skill with delicate manipulation, it is not advisable that any but a veterinary surgeon should undertake it.

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BOARD OF AGRICULTURE AND FISHERIES.

Farmers' Co-operative Societies.

The purchase of goods in large quantities by an associated group of persons for distribution amongst themselves according to their needs was one of the earliest forms of co-operation in England, and where the goods were sold retail in small quantities, as in the case of the large working class co-operative stores, the advantages of the system were quickly recognised. The application of the principle to the co-operative purchase of farming requisites, on the other hand, has made but slow progress in this country, and farmers generally have, in the past, been disposed to doubt the possibility of obtaining by combined effort any better prices than those which each individual could obtain for himself by bargaining directly with merchants and dealers. There are a few large associations which have a history extending over thirty or forty years, but it is only recently that any considerable advance has been made in the formation of societies for this purpose. There is little doubt, however, that their advantages are now much more generally admitted than was the case some ten or fifteen years ago.

The benefit of co-operative purchase is most obvious in the case of the small farmer who only requires to buy manures, cake, seeds, and implements in small quantities. By purchasing large quantities direct from the manufacturer and selling at a trifle above cost price, a co-operative society enables the small farmer to procure his goods at a much more moderate rate than he could by purchasing for himself alone from local dealers. He obtains the benefit of lower rates of carriage, and he is assured of the genuineness of the goods.

Such a society is not only in a position to buy from large merchants or manufacturers, but it can guard itself against adulteration or misdescription by analysis, the cost of which when applied to large consignments is proportionately unimportant, though the trouble and expense involved would tend to discourage the smaller buyer from protecting himself in this way.

Although it is evident that the benefit of such co-operative purchase is very great in the case of the small farmer, there is little doubt that it is equally advantageous to the large farmer, though for a less obvious reason. The quality of manures and feeding stuffs can practically only be tested by analysis, and even then some scientific knowledge is requisite to appreciate the results obtained and the relation between the price charged and the value represented by the analysis. Admitting that many farmers are fully qualified to bargain

on equal terms with those engaged in the trade, it is certain that there are many who are not, many more who are indisposed to take the necessary trouble, and many again who are inclined to rely unduly on the description of the goods furnished by the seller. To such, a co-operative society is of the greatest value, for they can depend on their interests being duly safeguarded in every way. They know that they are paying only the wholesale price of an article and they have the further assurance of freedom from adulteration, and correct description, because in such a society practically all inducement to overcharge disappears owing to the fact that any advantage taken of a member would only increase the profit which would afterwards be returned to him in the shape of increased dividend or bonus.

These advantages are best secured by a genuinely co-operative association, that is to say, a society in which the capital is subscribed by those interested as trading members, and in which the profits are distributed by paying a fixed rate of interest on the capital, and then dividing the surplus among the members in proportion to the extent to which they have participated in the business. Only members should be admitted to the advantages of the undertaking, which is carried on for their mutual benefit, and all should have an equal voice in the management.

Societies for the Sale of Agricultural Produce.

The co-operative principle may also be applied with success to the sale of agricultural produce.

It is not always realised that there are two distinct branches of the farming industry, viz. : (1) the productive and (2) the distributive. The object of societies for the sale of agricultural produce is to assist farmers in the second of these branches. At the present time growers attempt to deal with both branches of their business, and however well qualified they may be with regard to the productive side, it is probably not too much to say that a large proportion of the farmers of this country have a great deal to learn with regard to the distributive side. A co-operative society, on the other hand, can employ a qualified manager and staff to give their attention to the disposal of the produce sent in by members, as well as to the purchase of manures, cake, implements, &c.

This is being successfully done in the case of several large societies, but it is a direction in which there is much room for development.

Such societies may be of the greatest assistance to even the largest farmers, and for the success of the small holder they may be said to be essential. It is only by combining the small quantities of produce grown on a number of holdings that such produce can be sold wholesale on satisfactory terms, or that the reduced rates of carriage which are available for

large lots can be obtained. In no other way can the small holder hope to compete successfully on equal terms with larger growers or with foreign importers.

By sending produce to a co-operative society, the small holder is saved the trouble and expense of marketing his goods, and will be able to devote the time so saved to the cultivation of his holding. A double saving is thus secured.

A society for purchase can also be a society for sale, and it is useful to begin with the former class of business and proceed to the latter as the society progresses and prospers.

The secret of success of all co-operative trading, is solidarity of union. Every member of a society who undertakes to sell his produce at the society's store or depot is bound in honour to offer all his produce other than what is required for his own consumption. If he tries to sell his best produce privately and only sends his inferior stuff to the society he is acting unfairly and contrary to his own interests and those of his fellow members. This point cannot be too strongly insisted upon, and should form one of the rules of every society that is formed.

Another point is that profits should be divided in proportion to trade done, and not to capital invested. There are many societies formed on joint stock lines with which farmers may usefully and profitably trade, but these are not co-operative societies in the true sense of the word, and small local societies should not be formed on these lines. If profits are divided according to trade done every member has an additional inducement to support the society.

It is advisable that societies, unless very largely supported, should not attempt too extensive a business at the beginning. It is usually advisable to begin with one or two classes of produce, and to extend the business as experience is gained.

Small local societies should affiliate themselves to some larger society in the district and carry on their operations through or in conjunction with it.

Just as a combination of buyers in a small society is in a better position than a single buyer, so a larger combination of buyers can obtain more favourable terms than a smaller one. A group of small holders trading through a society including in its membership many large farmers is able to obtain as favourable terms as though its own purchases were on a big scale.

For instance, several members of a local society may require a ton or two of coals each. Their combined orders would enable the society to buy several truck loads and thus to obtain it at an appreciably lower price per ton than if each member had ordered his lot separately. A society, however, which includes a number of large farmers spread over a big district, may very probably be in a position to

make a contract with a colliery for several thousand tons of coal at a still cheaper rate, and the small Society by adding its demand for a few trucks not only assists the big Society to order more but shares in the benefit of the large order and obtains its coal at a lower price.

An Affiliated Society also benefits by the experience of the committee of management and of the paid staff attached to a society operating on a larger scale, while it is still free to manage its own affairs independently.

The cost of affiliation is usually very small. In some instances it is fixed at the rate of one 5*s.* share for every ten members, and since as a rule the whole of the share capital is not called up the cost of affiliation may be only about 1½*d.* or 2*d.* per member.

General.

When the formation of an Agricultural Co-operative Society is decided upon, the first step to take is to obtain the advice and assistance of some person of experience.

The Agricultural Organisation Society, of Dacre House, Dacre Street, Westminster, S.W., will give all necessary assistance as regards the formation of Co-operative Societies in England and Wales, while the Scottish Agricultural Organisation Society, 5, St. Andrew Square, Edinburgh, are prepared to act in a similar way as regards Scotland.

Both of these societies are organisations for promoting Agricultural Co-operative Societies, and do not themselves engage in trade.

The next step is to register the young society under the Industrial and Provident Societies Act of 1893, in order that it may have a legal existence and be able to enter into contracts. A small fee is charged for this, but by registration members get a security which an unregistered society cannot get. The Agricultural Organisation Society have drawn up a set of model rules, which have been approved by the Chief Registrar of Friendly Societies, and which can be obtained on application to the Secretary of the Society.

The following leaflets dealing with other forms of co-operation have also been issued.

No. 111.—Co-operative Egg and Poultry Societies.
No. 214.—Credit Banks.
No. 221.—Mutual Insurance of Live Stock.

4, Whitehall Place, London, S W.,
December, 1903.
Re-written, September, 1909.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

GRADING AND PACKING FRUIT AND VEGETABLES.

Intensive cultivation has in many places been carried to a high degree of excellence, and British horticulturists pride themselves, justly, upon their skill as producers. Admirable and necessary as the highest cultivation must always be, yet something more is required to ensure complete commercial success, namely, the conveyance of the produce in the best possible style to the market or to the consumer. It is at this point that too many fail, and a material proportion of unprofitable sales is mainly attributable to neglect in presenting goods in the most satisfactory manner. Proofs of this defect are evident in every British market, and the produce of the home grower may commonly be seen in direct contrast with that of his foreign competitors, to the conspicuous disadvantage of the former. It is the purpose of the following notes to give some directions which, with the exercise of intelligence in carrying them out, may assist in improving the selling value of both fruits and vegetables as produced in this country.

1.—Fruit.

To aid in grading fruits to the best advantage, it must be assumed that the preliminaries of successful cultivation have received due attention. The selection of the best varieties, suitable sites and soils, with every possible care in protecting the trees from attacks of insects and diseases, demand the cultivator's utmost skill and unceasing watchfulness. Further, in preparing for the actual work of grading, the method and time of gathering should receive the strictest attention, or much of the other labour will be reduced in value. It is not sufficiently recognised how readily all fruits are injured by rough handling. Even hard, unripe apples and pears are soon bruised, and not only do these marks show as serious defects in the appearance of the fruits, but the keeping qualities are also affected.

One general rule is applicable to all fruits, and that is they should never, if it can be avoided, be gathered when they are wet, especially if they have to be packed for sending a long distance.

In preparation for sorting, the fruits should be carefully spread on a table or bench, which may slightly slope to the front, and should be of a convenient height for the

packer to stand at. The soft fruits must be conveyed to the sorting room in shallow trays or baskets, so that they can be graded direct without turning them out. When experienced hands are employed some degree of sorting can be done at the time of gathering, thus saving further handling or removal of the fruits, and the grower should in every case endeavour to reduce this to the minimum.

Points to be Observed in Grading.

Several matters have to be considered in the actual work of grading, and an intimate knowledge of the characteristics of varieties is essential to the best results. The effects of seasons on large crops also demand attention; for the second grade of one crop might rank as the first of another. It is impossible to lay down a rule that would constitute a standard equally reliable under all conditions, but a general idea can be given of the relative values of different grades under similar circumstances.

The points of importance in classifying the best fruits are:—

1.—*Freedom from injuries and blemishes.*

2.—*Good, uniform size and shape.*

These two points are essential to all high-class fruits, and no defective, distorted, or undersized samples should be allowed in the leading grades of any kind.

3.—*Colour.*

This quality is a special one, which always possesses a marked value in fruits for dessert, and even amongst some used for cooking or preserving, as in apples, red currants, raspberries, and strawberries. A richly-coloured sample, though only of moderate size, will, if free from defects, often possess a higher market value than a larger and duller sample. Cox's Orange Pippin, for instance, may be sold in two grades, one large and dull or greenish-yellow, and the other a size smaller, but in its best colour, in which case the latter will command the larger price. This is true of many other fruits which have a characteristic colour, which is, however, sometimes deficient in the larger sizes.

4.—*High quality with ripeness.*

Mere size may also be a secondary consideration, provided the fruits are choice, in perfect condition for immediate use, and free from defects. This is especially true in the case of small packages of dessert fruits, such as the finest pears, plums of the greengage type, ripe cherries, peaches, and nectarines. A special market must be at command for such samples, or they should be sent direct to the consumers or retailers.

The bulk of fruit grading will, however, be mainly concerned with variations in size, provided the essentials of good form and freedom from defects are secured. It is of the

utmost importance to ensure that each grade is as uniform as close attention can make it, and then the full value of the work is most likely to be obtained.

Grading the Fruits.

A quick eye and some practice under good guidance will soon enable a packer to select the various sizes rapidly and in a uniform manner.

Apples.—Apples in particular can be readily graded into several sizes according to the variety and the crop. Occasionally four well-marked grades may be obtained, in other instances perhaps three, while sometimes only two are obtainable. The difference of a quarter of an inch in diameter will constitute a well marked grade. An American Association has adopted as the minimum standard for first grade apples of the largest types $2\frac{1}{2}$ inches diameter; while for the smaller types $2\frac{1}{4}$ inches is the minimum diameter for first grade fruits; in each case $\frac{1}{4}$ inch is allowed between the firsts and seconds. In practice it is found almost impossible to adhere to such exact grading; the general standard and range in size of the crop or variety must be judged, and the graduation founded upon this. These remarks especially refer to apples for cooking, or dessert apples equally well coloured, but what has been already said about the value of colour must be remembered, and a special grade of uniform size may be selected where there is a proportion of larger fruits deficient in respect to colour.

Pears.—Most of the details regarding apples are also appropriate to the grading of pears, but as a larger proportion of these are used for eating than cooking, they are more adapted for disposal in small packages, and hence repay the greatest attention in uniform grading. Several qualities can usually be obtained from one crop, and it generally pays best to sell in two or three grades, only those rejected in the selecting process being disposed of in bulk. Even when large crops from old orchard trees are being dealt with, a few dozens of the finest fruits carefully packed will help to raise the total returns considerably.

Stone Fruits.—These may be selected in various grades. *Plums for cooking* can be sorted into two or three grades, the largest fruit commanding the best market. A good medium size is in demand for bottling, and the smaller sizes are utilized in ordinary cooking or preserving. *Dessert plums* and *cherries* are readily graded on the same method, the finest in boxes or small packages and the others in bulk.

Soft Fruits.—Fruits such as *strawberries* and *raspberries* are worthy of much care, strawberries being sorted into at least two grades and sometimes into more. The best are placed in punnets, the next in small boxes, and a third grade can be sold in boxes or baskets holding from 6 lb. to 12 lb. Raspberries may be conveniently divided into two qualities

whenever a special sale can be commanded for the best fruits either in punnets or small boxes.

Nearly all other fruits also admit of some grading, even though it be only to the extent of excluding defective and malformed specimens; the results yield a satisfactory reward for the labour and expense.

Packing for Sale.

Wherever fruits have to be transferred a distance by road or rail, *the best culture and most careful grading may lose all their value through careless packing.* Many of the defects in market consignments are either due to this or materially increased thereby, and the complaints on this score are as frequent as those regarding inattention to grading. In dealing with fruits the following points should be remembered :—

1.—*Only perfectly sound fruits should be used.*

2.—*Packing must be done firmly, but without crushing.*

3.—*The best elastic odourless materials should be employed for packing.*

4.—*All choice and ripe fruits should be packed in small quantities in shallow packages.*

Baskets.—In the home trade baskets are much more extensively used than boxes, and the most common are *round baskets without lids* of the bushel, half-bushel, or half-sieve types. They are strong and durable, but are objectionable for all the best fruits as, even with the most careful packing, the top layers are liable to be bruised, and under careless methods they are certain to be damaged. When apples, pears, plums, cherries, or gooseberries are sent in such baskets a covering of paper, with straw or other material, is placed on the top and secured by cross pieces of willow or hazel, the points of which are forced through the sides of the basket below the rim. *Flat baskets with lids* are preferable but expensive, and the difficulty with them is that they must be charged for or returned. In extensive dealings with market salesmen baskets are supplied at very little cost to the producer, but where it is desired to promote more direct communication between the grower and the retailer or consumer some other method is preferable, or the producer must provide his own baskets.

It would be helpful in many districts if a local industry could be developed in cheap basket-making ; there are few places where suitable willows could not be grown, and the basket-making might be performed in the winter evenings. For useful information regarding willows and osiers suitable for the purpose named, see Leaflet No. 36.

Boxes.—Much could be said in favour of boxes for fruits, and, where only small sizes are employed, they may be purchased or made so cheaply that they can be included in the

price of the fruit, and thus all the trouble of returning or collecting empties is avoided. Their more general use under the right conditions would assist producers to avoid over-stocking the markets in seasons of heavy crops, and, by facilitating direct communication with the consumers, secure better prices. In a small way, boxes can be made at home at a cost of 1½*d.* to 1*s.* each ; on a larger scale, with the use of machinery, they may be turned out at about 8*s.* to 50*s.* per 100, according to the size, and boxes costing 1*d.* to 6*d.* can always be advantageously given with the best grades of fruit. Many of the leading railway companies have recognised this fact, and now supply boxes of various sizes at 1*s.* 6*d.* to 5*s.* per dozen, while several manufacturers also supply large orders at very reasonable prices.

Packing Materials.—Various materials are available for packing purposes, but much the best are the several grades of wood wool now prepared, the coarsest being suitable for large packages and heavy fruits, and the finest and softest samples for the choicest ripe fruits. But wherever it is to be in contact even with apples and pears only the softest make should be employed ; the rougher samples can be used for the bottom, or filling up at the top. All choice and delicate fruits should be encircled with bands of folded soft tissue paper, having a glazed surface, which must be in contact with the fruit. This is also required to place over the top layers, but a stronger paper is used for unripe apples or pears.

Method of Packing.—In the actual work of packing, an even layer of wood wool is placed at the bottom of the box or basket, this layer being covered with a sheet of paper, upon which the fruits are placed firmly. The best *plums*, *pears*, or *dessert apples* should never be in more than two layers, while they travel best in the smallest boxes holding one layer. If only one layer of fruits is made, the packing material at the bottom, and that at the top, besides the folded paper band round each fruit, will be all that is essential; but if there are two layers, they must be separated by two sheets of paper, between which sufficient fine wood wool must be evenly spread to prevent injury to the lower fruits, and form a firm bed for the upper ones to rest upon. From one to four dozen of the best dessert apples, pears, or plums may be so packed in one box with safety for a long journey. *Peaches*, *nectarines*, and *apricots* demand the utmost care, and must always be in single layers.

Strawberries may be packed in lots of from 3 lb. to 6 lb. of selected fruits, but the first-named quantity is the best for the finest fruit, and the smallest of the railway boxes just holds that amount conveniently, allowing for a little packing material at the top and bottom. A box of the same size will hold 4 lb. of best *cherries*, 3 lb. of *raspberries* without their stalks, 3 lb. *red currants* (closely packed), or 4 lb. of *black currants* ; but the

last two may be packed in 6 lb. to 12 lb. lots if not too ripe ; the smaller quantities are, however, preferable and safer.

The finest *early strawberries* should be packed in 1 lb. punnets, which may be either deep or shallow, round-plaited chip punnets, or square ones (with or without handles). The round punnets are best packed in trays with lids, and those generally employed will take six punnets. They are only used for the earliest and choicest fruits, when prices are good. Crates may be employed to hold several such trays, those large enough for six being a convenient size and weight. The square punnets are packed more closely together on sliding shelves, or in trays like the others in crates.

Grapes are packed in shallow or handle baskets, the points of the bunches towards the centre and the stalks secured to the sides or rims, the top of the basket being covered with stout paper tied round the rim ; some handle-baskets, however, are fitted with lids. The sides and bases of the baskets are sometimes padded, but they are then always covered with a soft glazed paper. The great point is to avoid rubbing the surfaces of the berries and spoiling the "bloom."

In every case, besides ensuring the security of the finest fruit, it should be displayed to the best advantage, and if the grade is uniform, as advised, a little coloured or white tissue paper to fold over the sides when the box is opened is of great value.

The practice of topping is a common proceeding in the packing of fruit to which the attention of the Departmental Committee on Fruit Culture was drawn. The tenor of the evidence was to condemn the practice as dishonourable, and it was shown that it had led to much trouble in the trade, grower, salesman, and purchaser alike being involved. In packing fruit topping should be strongly discouraged ; if the fruit is properly graded the results are likely to be far more satisfactory, and no opening is given for the grower to be accused of dishonesty.

Branding and Labelling.

The question of branding or labelling must be carefully considered, for where good fruit only is being dealt with, the use of the words "Seconds" and "Thirds" is apt to give rise to a misconception that is unfairly against the seller's interest. For the finest samples "Extra," "Select," or "Special" may be employed. Some growers mark the next grade A 1, and the next No. 1, or if the letter X is employed, XXX would be used for the first grade, XX for the second, and X for the third. Another method is to term the best "Selected No. 1," and the other grades "Selected No. 2" and "Selected No. 3." Something of this kind is necessary to indicate that the lower qualities are not refuse but properly graded fruits. A grower should adopt a uniform system, and adhere to it, so that his brand may become known and have a market value, and

every package should bear the name of the variety and quality boldly printed on the label. Growers who intend to make a substantial business, and who deal honestly in the best produce, should have their own names on the packages. This is sometimes objected to in a market, but if a grower cannot make his business through the ordinary channels he must try fresh ones. It is best to endeavour to supply the shopkeepers, or to develop a trade with private customers, and send direct to them.

The reduced rates at owner's risk on the railways, and the parcels post, afford ample means for enterprising men to work up a business in small packages of choice fruits if they take the trouble to do so, either by advertising, by circulars, or by trade letters.

2.—Vegetables.

As in the case of fruits most vegetables require careful preparation if they are to appear to the best advantage, either in the wholesale market or in the window of the retailer. This preparation should commence when the soil is made ready to receive the seeds, and only end when the produce is successfully placed on the market. To attain complete success grading and packing should receive every attention.

Grading the Vegetables.

The benefits derivable from careful and systematic grading are by no means confined to fruits, as vegetables also afford considerable encouragement to those who strive to make the most of them in the same direction. Especially is this the case with root crops, though in a general way the sorting adopted is of a very rough character.

Roots.—Potatoes are usually picked up in three sizes, the large tubers (or "ware") for sale, the seconds or "sets" (or "seeds"), and the small tubers (or "chats") to be used as food for stock. The large size should be again sorted into two or three grades; with them as with apples, a comparatively small proportion of coarse irregular tubers spoils the appearance of a large consignment. Even shape and uniformity of sample possess a distinct market value, and a medium sized potato having these characteristics, together with good quality, will bring a better return than huge distorted tubers of which size is the only recommendation. If an extra 6*d.* per bushel or £1 per ton can be secured by such care it may mean, with a good crop, sufficient clear gain to more than pay the expenses of cultivation.

A distinction can be made between the best or earliest *turnips* and *carrots* and the ordinary quality or crop in bulk, by marketing the former in bunches, while the latter are sent in bags or baskets.

Onions can be graded in several ways, the best being bunched or made into "ropes," while smaller sizes are sold

loose, the smallest ranking as pickling onions. It is always advisable to have several sizes, each sample fairly uniform, as some buyers have a preference for medium sized bulbs and others for large ones. In selling small quantities by weight the retailers have a difficulty with the largest onions, and usually find the medium size more convenient.

If roots are prepared for sale by being thoroughly cleaned it is a great help, and in any case wherever grading is followed all the best qualities should be so treated or the chief part of the labour will be nullified.

Pod-bearers.—Peas and *beans* should always be graded. Yet grading is seldom done by the grower, and, as with many other vegetables, it is usually left to the retailer. Large, well-filled pods of the former are always in demand, and if the colour is good their value is enhanced. But they are too often gathered without due care, and a number of insufficiently developed pods materially lower the value of the whole, while reducing future gatherings. Peas are frequently purchased from farmers by dealers who employ large gangs of pickers, men, women, and children. The peas are all torn off at one gathering and despatched to market in bags, old pods, well-filled pods, and flats being mixed. But this is a bad method. Two or three grades of peas can be readily formed, according to the condition of the crop and the varieties, some being much more even croppers than others. In supplying consumers direct, daily or at regular intervals, it is now becoming the practice to shell the peas, grade them by means of sieves, and consign to the purchaser in small boxes. *Dwarf kidney beans* and *scarlet runners* can be graded by selecting the long, straight, and even pods for the best samples, in smaller quantities, the bulk going for sale in bushel or half-bushel baskets.

Green Vegetables.—With such vegetables as *cabbages, savoys, kale* and *Brussels sprouts*, the principal point is to see that each sample is uniform and in the best condition, and this is largely a question of care in gathering. For ordinary markets the two first named must be large and have solid hearts; for special sale and for sending direct to consumers a smaller size, but possessing all the other essential characteristics, is often preferred. *Brussels sprouts* should always be sorted into two grades, all the firmest and most compact into one, and the looser, rougher sprouts into another; the increased price of the first will pay for this in the majority of cases. To *cauliflowers* and *broccoli* similar remarks apply, the whitest and most even heads constituting the first grade, the rougher and discoloured the second. As with cabbages, large heads are required in general markets, but for the best sales moderate-sized perfect samples are the most satisfactory.

Various Crops.—Rhubarb can be classed in two grades, the longest, straightest and best coloured forming "No. 1"

bundles. *Celery* may be divided into two or three grades, the heaviest and most solid in bundles for salad, the others loose for soups. *Asparagus*, too, should be placed in two or three grades, according to the length, substance and blanching; the smallest (Sprue) for soups; all the best in bundles of 25, 50, or 100, the last in larger numbers. *Seakale* can also be sorted, the whitest and best grown being placed in bundles set upright in baskets.

Tomatoes demand the utmost care in sorting; two, three and even four grades may be formed. The best are packed in boxes or shallow baskets. The brightest and most even coloured fruits take the lead; there is a special demand for the largest handsome fruits in some markets, but the principal general sale is for good, even-shaped, moderate-sized, uniform samples. *Cucumbers* are graded into two or three sizes; and *vegetable marrows* are also sorted, but in some places large specimens of the latter are most in demand, while in others a medium size is chiefly required.

Salading, like *lettuces* and *endive*, can occasionally be separated into two grades, but as a rule a uniform sample of one value is preferable, to be regulated at the time of gathering.

The general rules for grading vegetables of all kinds may be stated as follows:—

1.—*All immature, over-grown, coarse, or defective specimens must be excluded from the leading grades.*

2.—*Each grade should be made as uniform as possible.*

3.—*Freshness and fitness for use should be the characteristics of all vegetables when consigned to market or consumers.*

To aid in all this only the best varieties obtainable should be grown, and growers should watch closely for every real improvement on old sorts.

Packing.

In packing vegetables most of the general advice already given should be serviceable; but vegetables are disposed of in larger quantities than fruit and therefore require a different class of packages. *Bags* of various kinds and sizes, with *large light open baskets* or *crates*, are more extensively employed than boxes.

Early Channel Island *potatoes* are consigned in baskets, and are sold by the pound, Canary goods being sent in boxes, four of which form a "bundle."

The majority of roots are sent in bags, but the best samples of *turnips*, *carrots*, &c., that are bunched are sent in crates, while *radishes* and small roots are sent in baskets.

Green vegetables, like *cabbages*, are best marketed in crates, as also are *broccoli* and *cauliflowers*, but the earliest and best of the last named are often packed in flat baskets or

hampers and pay for every care. Italian cauliflowers arrive in little chip baskets termed "chips." These contain 1½ dozen each. Cabbages from Evesham are packed in pots, about 2½ dozen in a pot according to size.

Foreign saladings, such as *lettuces*, are usually packed in crates. Selected cos lettuces are frequently forwarded for sale in boxes, realising higher prices in proportion as they are regular in size and are not damaged in transit. *Radishes* from France are packed in large baskets termed pots, these being of a different shape to Evesham pots.

Peas and *beans* are packed in baskets, usually bushels or half-sieves, but as previously noted peas when shelled are forwarded in small boxes containing about three quarts each. Half-sieves are also used for *Brussels sprouts*, *pickling onions*, and other small vegetables.

Forced *rhubarb* is consigned in boxes; the later crop goes to market in bundles, loaded direct into the vans, or packed in crates. *Celery* is treated in the same manner, and is sent from the Home Counties in the washed, but from Lincolnshire and Huntingdonshire in the unwashed condition.

For all early and high quality vegetables shallow baskets or boxes are useful. *Cucumbers*, *tomatoes*, *mushrooms*, and many others can be conveniently sent in this way, and where periodical consignments of general vegetables are sent to private customers this is the best method.

It is necessary to pack firmly as with fruits, and where green or perishable vegetables have to travel a long distance it is desirable to gather them as shortly before packing as possible, preferably in the early morning when quite fresh, but not when drenched with rain. They should not be allowed to remain exposed to sun or wind for some hours before they are sent off, as they sometimes are, to the obvious disadvantage of the seller. Defective or decaying samples should on no account be admitted into the packages; the uniformity so strongly recommended as regards fruits should be maintained, and it will be found that the reputation gained is a satisfactory reward for the extra care.

4, Whitehall Place, London, S.W.,
December, 1903.
Revised, July, 1906.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Relationship of Woods to Domestic Water Supplies.

This subject has, for more than twenty years, occupied much of the attention of Forest Experimental Stations, especially in Germany, France, Austria, and Switzerland; and in view of its importance the conclusions arrived at may be usefully summarised.

It has been asserted, and theoretically the contention is doubtless correct, that masses of woodland increase the rainfall. The causes of this result are sought for in the reduction of temperature associated with forests, and in the greater absolute and relative humidity of the air in woods. But although it may be possible to obtain experimental proof by means of elaborate and long-continued observations in a region where extensive afforestation or deforestation is taking place, it may at once be said that such tree-planting as is practically possible in Britain can have no appreciable influence on the rainfall. Trees do, however, under certain conditions of the atmosphere, condense dew on their leaves and branches, and this effect may often be seen in the wet state of the ground underneath trees on a foggy morning, when the surface elsewhere is comparatively dry.

But the case is materially different where the fate of the rain and snow that falls on a tract of woodland is considered. The foliage, branches, and stems of the trees intercept much of the rain and snow so that it never reaches the ground at all, the amount so intercepted usually ranging from 30 to 45 per cent. of the total, but much depends on the character of the rainfall, and on the species of tree. In a district of heavy annual rainfall a smaller proportion of the precipitations is caught by and evaporated from the trees than where the rainfall is light. Similarly in the case of heavy and long-continued rain, as contrasted with gentle showers; in the latter case, in fact, but little of the water reaches the ground through the leafy canopy of a dense forest. Then again much depends on the kind of tree, evergreens intercepting more water throughout a year than deciduous trees,

and a larger proportion of the rainfall is evaporated from the leaves and branches in summer than in winter.

But although less rain-water reaches the soil of a wood than finds its way to the ground in the open country, the moisture in the soil is much better conserved in the former than in the latter case. Long-continued observations have shown that more water drains from a wooded area than from one devoid of trees. The greater abundance of water in forest soil, in spite of the trees intercepting a large proportion of the rain-fall, is due partly to the reduction of evaporation owing to the exclusion of the sun's rays by the foliage, partly to the air in a forest being more humid, and thus better fitted to discourage evaporation, and partly to the absorbent and retentive character of the decaying vegetable matter that covers the ground of a dense and well managed wood. The lace-work of tree roots, too, that occupy the soil of a forest, offers mechanical resistance to the rapid surface-flow of water. It is also to be noted that roots penetrate to great depths, and when they die they leave holes through which water readily penetrates from the surface. The friable condition of the soil of a wood, too, permits ready percolation of water, whereas in the open country the denser character of the surface of the ground is less favourable to the entrance of water. The consequence is that streams in a wooded country are not so subject to rapid rises and falls, the flow being maintained more equably throughout the year. Where water supply for domestic or industrial purposes is concerned, the avoidance of violent freshets on the one hand, and scanty flow on the other, is alike desirable. Not only may the water of sudden and heavy floods be lost owing to the incapacity of the reservoir to contain it, but such floods have also the disadvantage of carrying much mud and similar material in suspension, and this gradually silts up reservoirs, besides entailing increased expenditure in filtering.

It may be pointed out that the water of a reservoir surrounded by well stocked woodland is not subjected to the same amount of violent agitation during gales as is the case when such sheltering agency is absent. The mud and silt deposited on the bottom, and especially along the margin, is consequently left comparatively undisturbed, with corresponding advantages in the matter of purity.

When a catchment area is covered with trees, and with the vegetable matter that accumulates on the surface of the ground, the water that reaches the soil as rain is impeded in its flow, and its evaporation is hindered, so that the general effect is equivalent to an increase in the size of the reservoir. It is also important to note that snow melts more slowly underneath trees than in the open country, so that at a time of thaw the snow-water is yielded up more gradually. Nor must the fact be overlooked that when snow in a

forest melts, the ground absorbs the water to a much greater extent than happens in the open country. In the latter case the ground is probably frostbound, so that the snow-water cannot be absorbed by the soil, whereas forest soil, being protected by trees, never freezes to the same extent, and is consequently in a better position to absorb snow-water. The result is that not only does a forest mitigate the violence of floods, but the snow-water that flows from its area is less muddy than would otherwise be the case.

Forests not only affect the degree of moisture in soil, but they also exert considerable influence on the soil temperature. Although this influence is greatest at the surface of the ground, it is also perceptible to a depth of several feet. On the average of a large number of continental stations it was found that woods of various species and ages depressed the mean annual temperature at the surface of the ground by about 2·6° F., while even at the depth of four feet the reduction of temperature was 2°.

This general cooling influence is due to a variety of causes. The foliage of the trees excludes the sun's rays, the decaying vegetable matter that covers the ground prevents the free exchange of air between the soil and the atmosphere while the water in the soil absorbs much heat without its temperature being much affected.

While woods have a depressing influence on the mean annual temperature, it is found that this effect is usually confined to the period of summer. On the average of 11 German stations the July temperature of the surface soil in the forest was found to be 7° F. lower than that in the open field, whereas in December the former was rather warmer than the latter. Forests, therefore, tend to equalise the temperature of water collected in them, the temperature being slightly raised in winter, and markedly reduced in summer. This result would appear to be of considerable practical and hygienic importance where a supply of water for domestic purposes is concerned.

To the credit of forests is also to be placed the fact that they exercise a purifying influence both on the air and on the soil, germs of all kinds being markedly scarcer in a well-wooded district than in a similar extent of tree-less country.

4, Whitehall Place, London, S.W.,
January, 1904.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 20 leaflets dealing with Forest Trees and their Diseases may be obtained from the same address, price 1d., post free.

Leaflet No. 100.

BOARD OF AGRICULTURE AND FISHERIES.

Pig Breeding and Feeding.

To manufacture a first class carcase of pork from an ill-formed badly-bred pig is almost as difficult as "to make a silk purse out of a sow's ear." The selection of the parents of the young pigs which are to be fattened is, therefore, of vast importance. Where possible, it is best to obtain the service of a pure-bred boar, which should be of good quality, fine in bone and hair, lengthy and deep in back and hind quarters, with comparatively light fore quarters, and of a quiet disposition. An old or heavy boar should not be mated with young or small sows. The brood sow should possess as many of the above points as possible, with at least twelve teats, placed as nearly as possible equi-distant from each other and commencing close behind the forelegs of the sow.

The Sow.

Many persons consider that the purity of breed of the sow is not so important, but, as with the boar, pig breeders cannot be too strongly urged to keep for breeding only those young pigs which are the produce of prolific, good tempered, and free suckling sows. Too much attention cannot be paid to these three most important points. Young sows should not be allowed to farrow until 12 months old, while better results may be expected at 15 months. No sow should have more than two litters in one year. Old pig keepers have observed that the produce of sows that farrow large litters of even-sized pigs fatten more quickly and require less food for a given increase in weight; and it is also a fact that the produce of the more lusty and muscular sows, which are usually in good condition, are better growers and thrivers than the pigs of smaller litters from weakly and delicate sows. Matured sows will produce a greater number of pigs, which are often more thrifty in many ways, than will the young sows which are too early mated with the boar.

It should be remembered also that sows continue to produce good pigs for several litters. Considerable attention is at the present time being given to the system which is common in some of the northern counties of rearing but one litter of pigs and then fattening the sow. One of the reasons given for this plan is that the young sow when fattened will take the place of a fat castrated male or a spayed female pig, and thus realise more per pound than would an aged sow when fattened; also that

in these districts the majority of the pigs are fattened within a certain few months, and, therefore, it would not pay to keep the older sows to produce only one litter per year. Neither of these reasons appears to have much force, since it is generally acknowledged that the most successful pig feeder is the one who has fat pigs to sell at all periods of the year, but particularly in months when the highest prices are obtainable for pork. It is perhaps on the whole better to fatten off the average sow after her third or fourth litter.

The system of killing off all the young sows also makes it impossible to improve one's stock of pigs by reserving the future breeding stock from the litters of the sows which have proved themselves to be superior milking sows and the most prolific. These are two qualities which are of the greatest importance, but which can only be discovered by the actual results of two or three litters from each sow. The continued selection by certain breeders of the best pigs from such sows has rendered their pigs superior to those in any part of the world.

The best Type of Pig.

There exists considerable difference of opinion as to the type or style of pig most generally profitable. The first point to be considered is the market which the pig breeder proposes to supply; in some districts near London and some other large towns the chief demand is for pigs of some four to five months old and weighing about 60 lb. dead weight, or some 85 to 90 lb. alive. The Middle White Yorkshire sow is much kept, and crossed either with a boar of the same breed or a Berkshire; some breeders prefer to cross the other way, but the pigs from the Middle White sow are generally more numerous and grow faster when young.

The form and weight of the fat pigs required in other districts varies from the so-called bacon curers' pigs of some 160 lb. dead weight to the 220 lb. to 300 lb. somewhat fat pig most in demand in parts of Yorkshire, Lancashire, and other counties. Very much the same type of pig is needed to furnish both classes of fat pigs. The finer quality Large White is the more general favourite, but in some districts the Berkshire and the Tamworth pigs, both pure and crossed, and the Large Black pigs of the two different types which are to be found in Cornwall and Essex, are preferred.

Quick Fattening.

Pigs for Pork.—The term of life of the fat pig should be so short that the climate cannot materially affect its growth and thrift, or, in other words, the life of the pig should consist of only one part, the fattening period, not, as is far too frequently the case, a long store period, to be followed later on by a more or less long time in being fattened. An

enormous loss is sustained by the adoption of the second system, as, after the pig has reached the age of three months, the cost of producing a pound of meat from it will gradually increase, so that a loss results after a few months. The cause of this is not far to seek; the young and growing pig can and does utilise all the constituents of the food, so that the growing and feeding progress simultaneously, whilst the older or store pig really needs only those constituents of the food which are required to fatten it, so that the other constituents not utilised are simply wasted. Besides this a certain quantity of food is required simply for its upkeep, so that if the pig lives only a month longer than is absolutely necessary the value of this amount of food is thrown away.

Bacon Pigs.—In the case of bacon pigs, when a large frame is required, a store period is unavoidable, and this applies equally to pigs fed on town refuse, only large store pigs being suitable for so strong and rich a diet.

Spaying.—The spaying of the sow pigs intended for small porkers is an unnecessary operation, as they are slaughtered at 5 to 6 months old. The practice of spaying is falling into disuse in many parts of the country. The plan of making the sow pigs into small pork allows the boar pigs to be kept for bacon production at 10 to 15 months old.

Management.

The best system of management of sows and young pigs varies with the district. There is often a considerable quantity of available food which costs little, such as odds and ends from the garden and the house in the country, or from hotels or public institutions wherever they may be found. In many, if not in most, instances, the sow may be kept at little expense during the three months after her pigs are weaned—a run in a paddock or grass field during the spring and summer will usually be sufficient; then, when the grass loses its quality, or becomes less in quantity, the addition of some soaked maize, or peas or beans when prices admit of it, or even roots of almost any kind given raw—potatoes only being steamed or boiled—will suffice. Even the kitchen refuse from fair sized houses will go far towards the keeping of the brood sow. During the later stage of pregnancy the sow must be fed on more nourishing diet, since the drain on a sow in the production of a good litter is very considerable.

It is well to arrange for young sows to farrow during the warmer months. Especial care should be taken that at the time of farrowing the sty should be free from draught and wet, while a good bed of clean short or cut straw should be provided.

Farrowing. — In general the farrowing sow needs but little help. So few of the ordinary sows kept are accustomed

to the owner or attendant taking much notice of them that they will probably resent the offers of help when the pain and excitement attending farrowing render them more sensitive and nervous. There may be times when a little help is needed, as when one of the little pigs is presented doubled up, as sometimes occurs; then the attendant's hand should be well greased and carefully inserted, so that the pig is returned into the womb, when it will most probably be rightly presented and brought into the world. Again, piglings which are of abnormal size from any cause sometimes give the sow considerable trouble. If the sow is perfectly quiet, help can be given with profit by the attendant, care being taken not to use so much force that the sow is internally injured.

After the sow has finished farrowing, she should be given a small quantity of warm, sloppy food, while if the bed be very wet, it should be made up with an armful of short straw. The sow will then lie down and rest for several hours until her pigs are quite strong, providing they do not quarrel over the selection of their own particular teats; if they should bite the sow's udder, the little sharp teeth should be broken off with a pair of pincers. Those pigs which are carried more than the usual sixteen weeks frequently have long and sharp, and sometimes dark coloured, teeth, which are very sharp; to break these off is a necessity. The sow will usually show that the pigs' teeth require attention, by lying upon her belly and refusing to suckle them; if this be continued for any length of time the collection of milk will cause inflammation of the udder, with disastrous results.

Young pigs should not be allowed to lie on or burrow under hot manure, or they may become stunted in growth, and subject to disease. The better the sanitary conditions under which they are kept the better will be the results, and the earlier will the young pigs be fit for slaughter.

Feeding the young Pigs.—When the pigs are about a month old they will commence to eat some of the sharps fed to the sow; it is then a good plan to turn the sow out of the sty for an hour or two, and to give the little pigs a few peas or kernels of wheat to eat. Many persons make the mistake of only feeding the freshly weaned pigs twice a day, forgetful of the fact that the sow suckles her pigs from eight to twelve times a day, as they grow older. Their stomachs are not intended to stow away large quantities of food at a time.

Meals of any kind must not be given too thick; all the pig's diet should be sloppy.

Hard grain, if given at all to young pigs, should be given sparingly. Food which is too thick, or the free use of grain, is frequently associated with (dietetic) convulsions, and this trouble is a source of much loss among young pigs.

Tuberculosis in Pigs.

Too much stress cannot be laid on the fact that a very considerable number of carcases of tuberculous pigs have of late been sent to the London markets for sale as human food, and many persons have been prosecuted on this charge, and in some cases heavily fined. Pig breeders and feeders are cautioned therefore against the risk of prosecution which they incur by disposing of such tuberculous carcases. Tuberculosis is by no means uncommon in pigs, and is probably caused chiefly by feeding them on refuse milk from dairies in which cows with tuberculous udders exist, and on diseased offal from cattle. Especial care should therefore be taken to prevent swine from coming into contact with any parts of the internal organs of diseased cattle, and refuse milk, if given at all, should be previously raised to the boiling point. When a cow has one or more hard quarters, her milk should not be fed to the pigs unless it be first boiled.

The indications of tuberculosis in the pig's carcase consist mainly of hard swellings in the glands around the throat, and the presence of white cheesy-looking deposits of tubercular material in the mucous membrane of the intestines, in the mesenteric glands or in the lungs. In the event of any of these conditions being found after death, the owner should not send the carcase to market without ascertaining from the Sanitary Inspector of his district or from his Veterinary Surgeon that the carcase is free from tubercular disease.

Improved sanitation and periodic disinfection of premises should be the order of the day wherever pigs are kept, and all empty pens should be carefully disinfected before the introduction of fresh stock.

Swine Fever.

In order to avoid infection purchasers of pigs should always keep the newly-acquired animals separate from the home herd for at least a fortnight; and farmers should be careful not to allow persons who may have been in contact with diseased swine to handle, or even to approach, their pigs.

Leaflet No. 29 (*Swine Fever*) and No. 121 (*The Construction of Pigsties*) should be read in conjunction with the present leaflet.

4, Whitehall Place, London, S.W.,
January, 1904.
Revised, May, 1907.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

GENERAL INDEX.

Figures in large type (e.g. **57***) indicate the number of the Leaflet, and those in small type (e.g.* 4*) the page of the Leaflet. Generic and specific names are given in italics. Insecticides, fungicides, &c., are given in a separate index.*

SPECIAL INDEX.

This index refers to insecticides, fungicides, &c.

Leaflets issued by the Board of Agriculture and Fisheries.

The Board of Agriculture and Fisheries publish a series of leaflets on subjects relating to agriculture, and other matters of practical interest to farmers. A copy of any one of these leaflets can be obtained on application to the Secretary of the Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. No charge is made in this case, and letters of application need not be stamped.

Larger quantities can be obtained for circulation among friends or other persons to whom they would be useful by persons willing to undertake to distribute them. Should more than 50 copies be applied for some statement should be made showing that the applicant is in a position to ensure that the leaflets shall not be wasted. Applications from school children cannot be entertained, but the Board are prepared to send an adequate supply for nature study or educational purposes on receipt of an application from the Head Master of any school.

The Board are also willing to send copies of twenty different leaflets, to be selected by the applicant, free of all charge. In the event of more than twenty different leaflets being required, applicants should forward stamps and ask for one or more of the sectional volumes of leaflets referred to below. In every case the cost of carriage will be defrayed by the Board.

Subscribers to the Board's monthly Journal receive each new leaflet issued during the period of subscription.

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The leaflets of the Board are offered for sale in two forms :—(*a*) Leaflets Nos. 1–100, and Leaflets Nos. 101–200, bound in stiff boards in single volumes, price sixpence nett each volume. The money must be sent with the order, but the books are sent post free, so no more than the actual price of the books ordered need be sent. (*b*) Leaflets 1–200 bound in paper covers in volumes at one penny each, or 9*d*. per dozen copies, post free. The titles of the volumes now in print are as follows :—(1) *Leaflets relating to Acts of Parliament and Miscellaneous Subjects*; (2) *Leaflets dealing with Farm Animals and Dairying*; (3) *Leaflets dealing with Diseases and Insect Pests of Farm Animals*; (4) *Leaflets dealing with Poultry and Bees, their Breeding and Management*; (5) *Leaflets dealing with the Cultivation of Fruit Trees and Farm and Garden Crops*; (6) *Leaflets dealing with Manures and Feeding Stuffs*; (7) *Leaflets dealing with Forest Trees and their Diseases*; (8) *Leaflets dealing with Wild Animals and Birds*; (10) *Leaflets dealing with Insect and other Pests injurious to Fruit Trees and Bushes*; (11) *Leaflets dealing with Fungi injurious to Farm and Garden Crops*; (12) *Leaflets dealing with Fungi injurious to Fruit and Fruit Trees.*

In remitting money in payment amounts of sixpence and upwards should be sent in the form of postal orders or cheques.

These bound volumes of leaflets can be obtained at the office of the Board of Agriculture and Fisheries, 8, Whitehall Place, and not elsewhere.

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OF THE

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The *Journal of the Board of Agriculture* is issued monthly, and is intended to keep landowners, farmers, and other persons interested in agriculture and horticulture, informed as to official, scientific, and economic matters relating to these industries. It contains signed articles by recognized authorities, accounts of recent experiments, and information about events and changes in Government regulations at home and abroad. It is usually illustrated.

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BOARD OF AGRICULTURE AND FISHERIES.

British Breeds of Live Stock.

With a view to the encouragement of the exportation of live stock, the Board of Agriculture and Fisheries caused a Handbook, descriptive of the principal breeds of British Live Stock, to be prepared for the information of foreign agriculturists visiting the Brussels and Buenos Aires International Exhibitions of 1910. This Handbook has now been placed on sale in this country, and will probably be found to be of service to all who are interested in the breeding of live stock, whether for exportation or otherwise.

The object of this handbook is to give an account of the principal characteristics of the British breeds of horses, cattle, sheep, pigs, and poultry, with a brief history of their origin, and of some of the principal animals which have formed the foundation stock of the pedigree animals of the present day.

A statement of the more important shows and places at which the animals of each breed can be bought, together with an indication of the average prices, is given for the information of prospective purchasers. For further particulars and for the names of individual breeders, readers are referred to the secretaries of the breeding societies, whose names and addresses are also given.

The handbook contains 137 pages of letterpress, and is illustrated by some ninety photographs of animals of the different breeds. It has been published in English, French, German, Spanish and Italian, and copies in any of these languages may be obtained direct from the office of the Board, price 1*s*. each, post free.

Edible and Poisonous Fungi.

The poisonous kinds of fungi are comparatively few in number, while there are some fifty species of fungi which may quite safely be eaten. With a view to enable residents in the country to distinguish accurately between poisonous and edible fungi, and thus to utilize to a greater extent those varieties useful for food, the Board have published 25 coloured illustrations of certain species which are more or less commonly found in Great Britain, with brief descriptions to assist identification. Copies of the volume, bound in paper covers, may be obtained direct from the Office of the Board, price 1*s*. each, post free.